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FOUNDED MONTHLY



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"You will be pleased to know that I have listened to programs broadcasted from the following stations:

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District Sales Offices

10 So. La Salle Street
Chicago

433 California Street
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POPULAR SCIENCE MONTHLY

APRIL, 1923; Vol. 102, No. 4
25 cents a Copy; \$2.50 a Year



Published in New York City at
225 West Thirty-ninth Street

Your Questions about Evolution Answered in Great Serial Story

ANOTHER gripping instalment of "The Story of Man and His World," Dr. E. E. Free's thrilling series on humanity's conquest of nature, appears on page 25 of this issue, to be followed by other instalments in subsequent issues of POPULAR SCIENCE MONTHLY. It is the story of man's ancestors and of his family tree, vividly and simply written.

Is man descended from monkey? Who and what were our ancestors? How and why was the complex machinery of the body invented? What was the origin of sex and the reason for it? What were the beginnings of the human mind? These are some of the questions to be answered for you in this series.

Publication of this series by Doctor Free, the foremost writer of popular science in America, is one of the notable feats of the year. Nothing like it ever before appeared in any magazine.

"**T**HE Story of Man and His World" is scientific without being technical. It is an absorbing romance of the amazing inventions by man, of the still earlier inventions made ages

ago by animals and by plants. It portrays clearly the drama of the earth, the heavens, and the waters. It tells the secrets of life itself.

"The Story of Man and His World" is a magnificent pano-

rama of the whole field of science. It carries you away—away from somber everyday life—to treasures of information and recreation. And it is written so that every one can understand it.

"The Story of Man and His

World" is more than a fascinating narrative. It is a liberal education. It is a summary of the world's experience and knowledge. It is big and vital. It is amazing in its application to life today.

Don't Miss These Big Features

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POPULAR SCIENCE MONTHLY

Issued monthly. Single copy, 25 cents. Yearly subscription to United States, its possessions, and Canada, \$2.50; foreign countries, \$3.

Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A.

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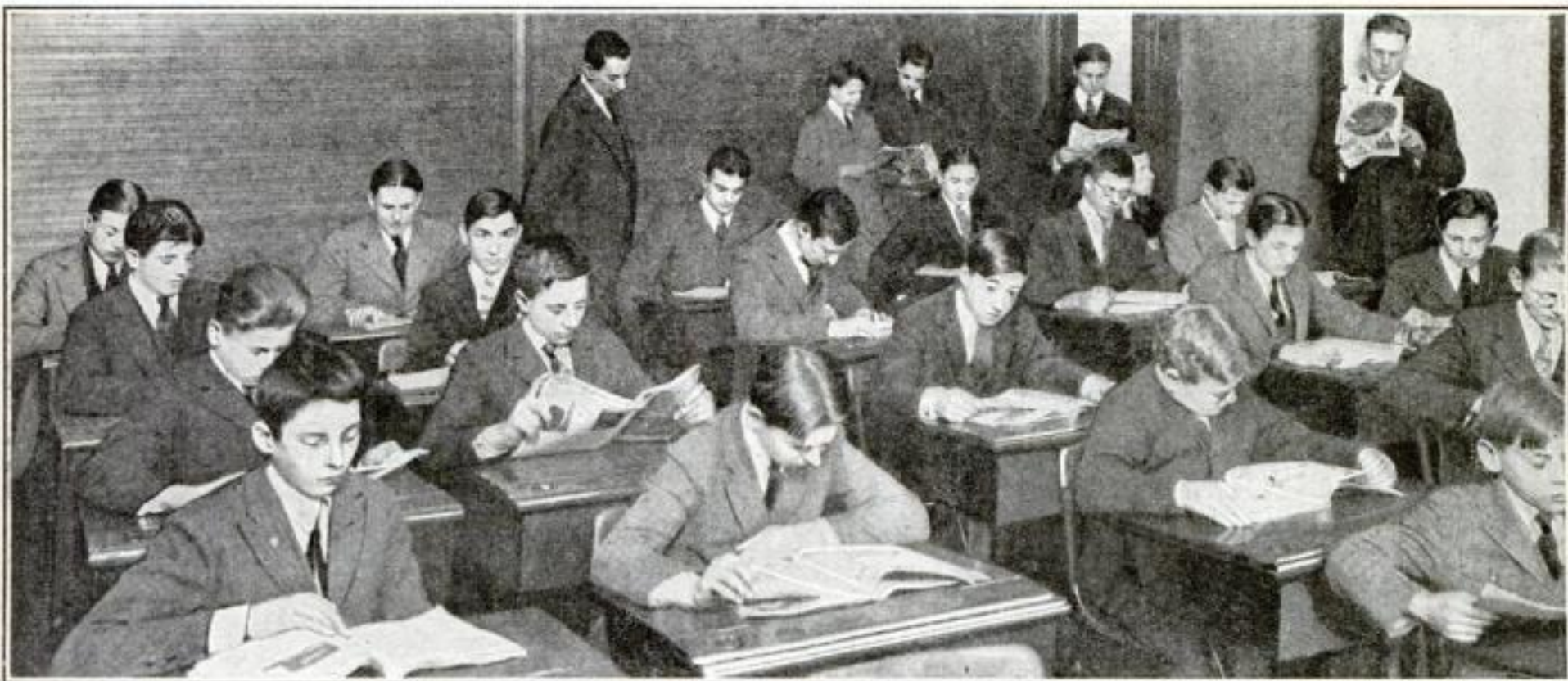
The contents of this magazine must not be reprinted without permission.
H. J. Fisher, President; R. C. Wilson, Vice-President
O. B. Capen, Secretary and Treasurer

BEGINNING in our May number, the stirring picture of man emerging slowly out of the simpler forms of life will be described. His spectacular conquest of other species and his subjugation of nature is to be depicted. It is a picture that will carry you through imagination-staggering time.

IN THE next few months POPULAR SCIENCE MONTHLY will publish the whole tremendous story, the greatest story that can ever be told to adults or to children. Simply and vividly written and superbly illustrated. Any one, no matter what his schooling, can understand every detail of it.

If you haven't begun reading this remarkable series, turn to page 25 of this issue. The May number of POPULAR SCIENCE MONTHLY containing the next instalment will be on sale at your newsdealer's April 10.

How Popular Science Monthly Is Used in Schools



IN THIS classroom of the Huntington School for Boys in Boston, Mass., the thrilling adventure story of the world's beginnings, as well as the important news of current developments in general science, invention, and radio, is being unfolded from month to month by the pages of POPULAR SCIENCE MONTHLY.

Here the boys and their professors have or-

ganized a Popular Science Club, with POPULAR SCIENCE MONTHLY as their textbook. And here Doctor Free's great serial, "The Story of Man and His World," comes each month to feed the minds of these youngsters with scientific facts about their world and to fire their imaginations with episodes of its dramatic history, pictured in understandable terms.

The Popular Science Club meets once a week for an hour. Each boy is supplied with a copy of the current issue of POPULAR SCIENCE MONTHLY.

Every week a certain number of the boys are assigned to lead a general discussion of some scientific or mechanical subject that has interested them in this magazine.



No need to wait for hours in the rain

Attend the opera and concerts as often as you have the opportunity, for great music should be part of every one's spiritual development. But on a stormy evening, how you will enjoy hearing the great artists through the medium of the Victrola and Victor Records in the comfort of your own home! Artists of your own choice in programs of your own choosing, such is the service at your disposal by means of the Victrola.



Victrola

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Important: Look for these trade-marks. Under the lid. On the label.
Victor Talking Machine Company, Camden, New Jersey

Both Are Embarrassed—Yet Both Could Be at Ease

THEY started out happily enough at the beginning of the evening. He was sure he had found ideal companionship at last. She was sure that she was going to impress him with her charm, her cultured personality.

But everything seemed to go wrong when they entered the restaurant after the performance at the theatre. Instead of allowing her to follow the head waiter to their places, he preceded—and when he realized his mistake he tried to make up for it by being extremely polite. But he made another humiliating blunder that made even the dignified waiter conceal a smile!

And now, at the table, both are embarrassed. He is wondering whether he is expected to order for both, or allow her to order for herself. She is wondering which fork is for the salad, which for the meat. Both are trying to create conversation, but somehow everything they say seems dull, uninteresting.

They will no doubt be uncomfortable and ill at ease throughout the evening, for it is only *absolute knowledge of what is right and what is wrong* that gives calm dignity and poise. And they do not know. She finds herself wondering vaguely what she will say to him when they leave each other at her door—whether she should invite him to call again or whether he should make the suggestion; whether she should invite him into the house or not; whether she should thank him or he should thank her for a pleasant evening. And similar questions, all very embarrassing, are bothering him.

The evening that could have been extremely happy, that could have been the beginning of a delightful friendship, is spoiled. He will probably breathe a sigh of relief when he leaves, and she will probably cry herself to sleep.

How Etiquette Gives Ease

Are you always at ease among strangers, are you always calm, dignified, well-poised no matter what happens, no matter where you chance to be? You can be—if you want to. And you *should* want to, for it will give you a new charm, a new power. You will be welcomed in every social circle, you will "mix" well at every gathering, you will develop a delightful personality.

By enabling you to know exactly what to do at the right time, what to say, write and wear under all circumstances, etiquette removes all element of doubt or uncertainty. You know what is right, and you do it. There is no hesitancy, no embarrassment, no humiliating blunders. People recognize in you a person of charm and polish, a person following correct forms and polite manners.

Every day in our contact with men and women little problems of conduct arise which the well-bred person knows how to solve. In the restaurant, at the hotel, on the train, at a dance—everywhere, every hour, little problems present themselves. Shall olives be taken with a fork or the



Shall she invite him into the house? Shall she ask him to call again? Shall she thank him for a pleasant evening? In rapid confusion these questions fly through her mind. How humiliating not to know exactly what to do and say at all times!

fingers, what shall the porter be tipped, how shall the woman register at the hotel, how shall a gentleman ask for a dance—countless questions of good conduct that reveal good manners.

Do you know everything regarding dinner etiquette, dance etiquette, etiquette at the wedding, the tea, the theatre, the garden party? Do you know how to word an invitation, how to acknowledge a gift, how to write a letter to a titled person? Do you know what to wear to the opera, to the formal dinner, to the masquerade ball, to the luncheon?

The Book of Etiquette

Complete in Two Volumes

In the famous two-volume set of the Book of Etiquette the subject of correct form for every occasion is covered completely, authoritatively. It is recognized as the most thorough and reliable book on the subject available today. It is encyclopedic in scope, answering every problem of etiquette that may be puzzling you in a clear, definite, interesting way. Nothing has been forgotten. Even the ancient origin of customs has been traced, and you are told exactly why rice is thrown after the bride, why black is the color of mourning, why a tea-cup is usually given to the engaged girl.

With the Book of Etiquette to refer to,



And now, at the table, both are embarrassed. Indeed, can there be any discomfort greater than that of not knowing what to do at the right time—of not being sure of one's manners? It is so easy for people to misjudge us.

you need never make embarrassing blunders. You can know exactly what to do, say, write and wear at all times. You will be able to astonish your friends with your knowledge of *what is right* under all circumstances.

A great deal of your happiness depends upon your ability to make people like you. Someone once said, "Good manners make good company," and this is very true. Etiquette will help you become a "good mixer"—will aid you in acquiring a charming personality that will attract people to you. Because you will rarely be embarrassed, people who associate with you will not feel embarrassed—your gentle poise and dignity will find in them an answering reflection and you should be admired and respected no matter where you are or in whose company you happen to be.

Sent Free for 5 Days' Examination

The Book of Etiquette will mean a great deal to you. It has already opened the doors of social success to many, has shown hundreds of men and women the way to obtain the poise and charm their personalities lacked.

Let us send you the famous two-volume set of the Book of Etiquette free for 5 days' examination. Read a few of the chapters—you will enjoy particularly the chapter on "Games and Sports" and the chapter called "When the Bachelor Entertains." If you are not delighted with the books you may return them within the 5-day period without the least obligation. If you are delighted—as everyone is who examines the books—just send us \$3.50 in full payment and the books are yours.

Don't make the mistake of putting it off. Here is your opportunity to examine the Book of Etiquette without cost or obligation. Mail the coupon now. Nelson Doubleday, Inc., Dept. 254, Garden City, N.Y.

NELSON DOUBLEDAY, Inc., Dept. 254, Garden City, New York.

You may send me the two-volume set of the Book of Etiquette for 5 days' free examination. I will either return them within the 5-day period or send you only \$3.50 in full payment. This does not obligate me in any way, and I need not keep the books if I am not delighted with them.

Name.....

Address.....

☐ Check this square if you want these books with the beautiful full-leather binding at \$5.00 with 5 days' examination privilege. (Orders outside of the U. S. are payable cash with order.)

Why Do You Laugh at a Joke?

Can you laugh if you are cold?

What makes a fat man funny?

Is laughter contagious?

What is a joke?

WILL ROGERS

Film Star, Author, and Cowboy Comedian of the Ziegfeld Follies

will answer these and a score of other interesting questions about the muscular mechanism and evolutionary origins of laughter in the next issue of
POPULAR SCIENCE MONTHLY

¶ For many years Will Rogers—of the swirling lariat and infectious grin—has held genial sway as one of the greatest comedians and humorists America has ever known. Thousands—among them three Presidents—have laughed at Will's quaint comments on men and affairs.

¶ Audiences laugh at his jokes because he has made a scientific study of laughter—he has learned what makes us laugh and why we often fail to laugh when it seems we should. He knows in advance how audiences will respond to the “laugh lines” in his monologues. He has mastered the secrets of his trade.

¶ He is going to reveal those secrets and other tremendously interesting things—learned during an unparalleled career on the stage and before the motion picture camera—in an exclusive article in the next issue of POPULAR SCIENCE MONTHLY.

¶ This and a dozen other features—concerning radio, your body and mind, new discoveries in science and industry—will make the May number a BIG issue. Ask your newsdealer to reserve your copy now—or, better—make sure of every issue for the coming twelvemonth. Detach the coupon at the bottom of the page.

POPULAR SCIENCE MONTHLY,
225 W. 39th St.,
New York, N. Y.

Please enter my subscription for one year for \$2.50.

NAME.....

ADDRESS

4-23



In every man's life there is one Big Moment when he makes the decision that either robs him of success—or leads on to fortune

Your One Chance to Earn The Biggest Money of Your Life!

HAVE you ever considered why our richest men come from our poorest boys? Isn't it a strange thing that it is almost invariably a young fellow who starts life without a cent in the world, without education, without influential friends—in short, without one single solitary advantage—who accumulates millions of dollars? Isn't it a miracle that inside of a comparatively few years a man can rise from abject poverty to fabulous wealth?

The Secret That Makes Millionaires

Astonishing, certainly—but more important, it is wonderfully inspiring. For it means that no man need be held down by circumstances. Once he knows the "millionaire's secret," he can put it into operation regardless of all obstacles that seem to block his path. He suddenly finds that everything he touches turns to gold—money flows in upon him—fortune showers him with its favors. Everything he wants seems to come to him just as surely and easily as day comes after night.

What is this amazing secret that can work such wonders? It is just this: **The thing behind all big achievement is Opportunity.**

To every man there comes one BIG Opportunity—the golden chance of his life. And in the moment he decides for or against that opportunity

—whether he will seize it or let it pass—he decides the whole future course of his life.

Choose Between Low Pay and Magnificent Earnings

This very minute **you** may be face to face with **your** BIG opportunity—your **one** chance to earn the biggest money of your life! Right now your decision may mean the difference between a life of plodding, routine work at low pay and a career of inspiring success and magnificent earnings.

For now you are offered the very opportunity that has made other men rich, that has brought them more money than they ever dreamed of earning.

It is the same opportunity that lifted Warren Hartle of Chicago out of a job in the railway mail service where in ten years he had never gotten beyond \$1,600 a year, and landed him in a \$10,000 a year job. It jumped Charles Berry of Winterset, Iowa, from \$60 a month as a farm hand, to \$1,000 a month. It brought to C. W. Campbell of Greensburg, Pa., a clerk on the railroad, a position that paid him \$1,562 in thirty days.

These men and hundreds more have found their **Big Opportunity** in the wonderful field of Salesmanship. They are all Master Salesmen now. They are earning the biggest money of their lives—more than they ever thought possible—they are engaged in the most fascinating work in the world—they are independent, come and go as they please—they meet big men—every minute of the day is filled with thrilling variety.

Your Big Opportunity may be here too, in the wonder field of Salesmanship. Perhaps

you say you have never even thought of becoming a Salesman. But before you decide one way or the other, examine the facts for yourself. See what Salesmanship offers you—why it is the best paid of all vocations—why there is no limit to what you may earn. Read the amazing proof that no matter what you are doing now, you can quickly become a Master Salesman in your spare time at home—read how the National Salesmen's Training Association in its nation-wide search for men to fill the great need of Salesmen, has devised a wonderful system that reveals to you every Secret of Selling without interfering in the least with your present work. See how this famous organization helps you to a good position in the line of Selling you are best fitted for.

Facts That Will Amaze You—Sent FREE

Mail the coupon below. This will not cost you a penny—it places you under no obligation. It simply means that you will receive entirely FREE, a wonderful, illustrated Book, "Modern Salesmanship," and Proof that you can be a Master Salesman. You will receive, also, the personal stories of men throughout the country who today are enjoying magnificent success and earning five, ten and fifteen times as much money as ever before.

Send NOW—this minute may be the turning point in your life. Address, National Salesmen's Training Association, Dept. 15-D, Chicago, Ill.

National Salesmen's Training Association,
Dept. 15-D, Chicago, Ill.

I simply want to see the facts. Send me FREE your Book "Modern Salesmanship," and Proof that I can become a Master Salesman. Also tell how you can help me to a position and send list of lines with openings for Salesmen.

Name.....

Address.....

City..... State.....

Age..... Occupation.....



MONEY MAKING OPPORTUNITIES for "Popular Science" Readers

\$25.00 in PRIZES

To win one of these cash prizes is easy, and every reader is invited to enter this fascinating competition. Just write a letter of not over seventy words answering this question:—

What advertisement of "Money Making Opportunities" in this issue interests you most and why?

Here are the prizes we will pay for the ten best letters answering the above question:—

First Prize \$10.00
Second Prize 5.00
Third Prize 3.00
And 7 Prizes
of \$1.00 each 7.00

First read every one of the "Money Making Opportunity" advertisements on pages 6 to 21. Check the ones that interest you. Then read over the ones you have checked and decide on the one that interests you most.

Then write a short letter, not more than seventy words, telling us why the advertisement you pick interests you most. Remember that ten prizes will be awarded. You have a good chance of winning one of them. Be sure to mail us your answer before April 1st. The prizes will be awarded, in the order of their merit, for the letters that are most interesting and best expressed.

The names of all the prize winners and the letters that win the first two prizes will be printed in this column in the June Issue. Address your prize letter to—

Contest Editor

POPULAR SCIENCE MONTHLY
225 West 39th Street, New York City

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Rate 25 Cents a Word. Advertisements intended for the June issue should be received by April 5th

ADDING MACHINES

POCKET Calculator, \$2.00. Adds, subtracts. Agents wanted. Bell & Co., 101 Maiden Lane, N. Y. City.

FREE trial, marvelous new adding machine. Adds, subtracts, multiplies, divides, automatically. Work equals \$350.00 machine. Price only \$15.00. Speedy, durable, handsome. Five-year guarantee. Used by largest corporations. Write today for catalog and free trial offer. Lightning Calculator Co., Dept. O, Grand Rapids, Mich.

TRADE SCHOOLS

EARN more money—Learn sign painting, scenic painting, showcard writing, auto painting, paper hanging, decorating, graining, marbling, at Chicago or at your home. Chicago Painting School, 157 West Austin Avenue, Chicago.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

RADIO SUPPLIES

RADIO and electrical supplies. Send for free monthly bulletin of bargains. Holmes Electric Co., Libertyville, Illinois.

A VACUUM tube hospital. We repair vacuum tubes and guarantee them to work. Dealers, agents wanted. George P. Porell Co., Inc., Dept. P. S., West Somerville, Mass.

VARIABLE Condensers—Capacity, 0005. \$1.48 postpaid. Cherpeck Company, 3123 Davlin, Chicago.

LOUD speaker for any crystal set. Hear music over entire house. Easily constructed by amateurs. Eliminates storage battery. Instructions complete, 25c. Catalogue 5c. Representatives wanted. Steinmetz Wireless Mfg. Co., East End, Pittsburgh, Pennsylvania.

FORMULAS

FREE—Formula catalog. Laboratories, 4600 Boylston Building, Chicago.

3,500 FORMULAS, recipes, trade secrets, 424 pages, \$1.00. Hillside Laboratories, 7021D South Winchester, Chicago.

FORMULA catalog free. C. A. Lutz, Apartment 241, York, Pennsylvania.

INK Eradicator (original) and other valuable formulas. Utility Service, P. O. Box 32, Hull, Quebec, Canada.

FORMULAS of the better sort. Write for our free catalog. National Scientific Laboratories, 213 North Monroe, Richmond, Virginia.

FORMULAS—All kinds. Catalogue free. Bestovall Laboratories, 4047-PQ North Whipple, Chicago.

MOTORCYCLES, BICYCLES, SUPPLIES

DON'T buy a bicycle motor attachment until you get our catalogue and prices. Shaw Mfg. Co., Dept. 4, Galveston, Texas.

AVIATION

FLY 100 miles an hour in a White 600. Complete \$665, knockdown, \$295, working drawings \$3. Send Now! White Aircraft Corporation, 406 South Main, Los Angeles.

THE American School of Aviation announces a new correspondence course in mechanics of aviation. A thorough training in practical aeronautics. American School of Aviation, Dept. 1744, 3601 Michigan Ave., Chicago, Illinois.

PROPELLERS for aeroplane propulsion, 5-foot diameters, \$12; 6-foot for Ford, \$15; others in proportion. Motorcycle sleigh blueprints, 75c, Ford size, \$1.00. Pictures free. Crawford Motor and Aeroplane, Long Beach, Calif.

INVENTORS desiring information write for our free Illustrated Guide Book and Evidence of Conception Blank. Send model or sketch of invention for our opinion of its patentable nature. Highest references. Prompt service. Reasonable terms. Victor J. Evans & Company, 151 Ninth, Washington, D. C.

NEWEST, most thorough and interesting home study course in aviation ever offered. Complete price \$19. Write Now! White Aircraft Corporation, 406 South Main, Los Angeles.

MOTORS, ENGINES, MACHINERY

PULLEYS, grooved and motor. Reducing gears. Light transmission machinery. Send for catalog. Winfield H. Smith, Lock Street, Buffalo, New York.

1/4 HP Westinghouse motors, new, AC \$12.00 each. We buy and sell motors and dynamos of every size and description. R. Scheinert Company, 123 N. Third Street, Philadelphia.

AMERICAN MADE TOYS

MANUFACTURERS on large scale, also homeworkers, wanted to manufacture metal toys and novelties. Millions needed of barking dogs, wag tail pups, wild animals, automobiles, Indians, cow-boys, baseball players, cannons, toy soldiers, crowing roosters, statues of Liberty, miniature castles of capital, bathing girl souvenirs and others. Unlimited possibilities. Guaranteed casting forms furnished manufacturers at cost price from \$5.00 up, with complete outfit. No experience or tools necessary. Thousands made complete per hour. We buy goods all year and pay high prices for finished goods. Cash on delivery. Contract orders placed with manufacturers. Catalog and information free. Correspondence invited only if you mean business. Metal Cast Products Co., 1696 Boston Road, New York.

PATENTS—Write for free Illustrated Guide Book and Evidence of Conception Blank. Send model or sketch and description of invention for our opinion of its patentable nature. Highest reference. Reasonable terms. Victor J. Evans & Company, 189 Ninth, Washington, D. C.

AUTOMOBILISTS. A pair of "Is-It-Lit" reflectors attached to your headlights will tell you when driving whether they are lighted. Two styles \$1.05 and \$1.58 the pair. The H. D. S. Co., 70 Walnut St., Somerville, Mass.

AUTOMOBILE owners, garagemen, mechanics, send today for free copy of America's most popular motor magazine. Contains helpful articles on overhauling, repairing, ignition, carburetors, batteries, etc. Automobile Digest, 523 Butler Bldg., Cincinnati.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

FORD ACCESSORIES

SPEEDSTER fans—see "Red-I-Kut" ad page 121.

FORD owners, don't ruin your car by leaving it chatter. Correct same by installing Bredar's Ball Shim. Price \$1.10. Ask your dealer or write for information. Nic Bredar's Son Mfg. Co., Rock Island, Illinois.

WANTED

DETECTIVES—Excellent opportunity. Fascinating work. Experience unnecessary. Particulars free. Write American Detective System, 1968 Broadway, New York.

CASH for old gold, platinum, silver, diamonds, Liberty Bonds, war, thrift, unused postage stamps, false teeth, Magneto points, jobs, any valuables. Mail in today. Cash sent, return mail. Goods returned in ten days if you're not satisfied. Ohio Smelting Co., 309 Hippodrome Bldg., Cleveland, Ohio.

WANTED—Representatives in every factory in the United States. Popular Science Monthly, 225 West 39th Street, New York.

HE a detective. Excellent opportunity, good pay, travel. Write C. T. Ludwig, 424 Westover Bldg., Kansas City, Missouri.

DUPLICATING DEVICES

"MODERN" Duplicators save Time, Labor and Money. Gets Business. Reproduces Typewritten or Penned Letters, Drawings, Letters, Music, Menus, Bids, Notices, Specifications, Maps or anything in one or more colors. Prints TWO per minute. Special sale on. 30 Days Free Trial. \$2.25 up. Booklet free. J. V. Durkin-Reeves Co., Pittsburgh, Pennsylvania.

MIMEOGRAPH Outfit Two Dollars. On approval. Primos Specialty Co., Bx. Primos, Pa.

LABORATORY AND CHEMICALS

EXPERIMENTERS. Complete supplies for the chemical laboratory. Catalogue 5c. National Scientific Supply Co., 241 Pennsylvania Avenue, Washington, D. C.

YOUR chemical problem solved and working process furnished for five dollars. Write me. W. Stedman Richards, Consulting Chemist, Box 2402, Boston, Massachusetts.

PHYSICIANS and Surgeons Diagnostic Laboratories of Philadelphia, 1633 Locust Street. Urine, blood, sputum, Wasserman's test and all examinations of the body fluids made. Send for containers and literature. Water for analyses—well water, drinking water and chemical formulas, dyes, drugs and patents. Dr. J. M. Rosenthal, Am. M.D., Ph. D., P. C. S., Director of Laboratories.

TELEGRAPHY

WANTED—Young men and women to learn Morse and Wireless Telegraphy. Railroads and Wireless Companies in great need of operators. We teach you quickly, and procure positions at big salaries. Great opportunities for advancement. All expenses low; can earn part. Write today for free catalog. School established 1874. Dodge's Telegraph Institute, Queen Street, Valparaiso, Indiana.

CONSULTING ENGINEERS

SCIENTIFIC Designs and Working Models of valuable inventions prepared and guaranteed. Consulting Engineer, 2 East 23d Street, Room 714, New York.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

MANUFACTURING

WE manufacture anything, design and build special machinery, develop inventions, build models, make drawings of every description, our facilities the best. Write for booklet. R. G. Clyne Engineering Co., St. Louis, Missouri.

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Suppose, when you went home tonight, you found a window rattling. Through your mind would flash, almost instinctively, a regular order of thoughts which characterize the conception and completion of every invention the world has ever known. First, you would recognize a problem to be solved—the rattling of the window. Then you would think of several principles of science or mechanics which would solve your problem. You might think of the scientific fact that if you poured water on the frame the wood would swell and tighten the window. You might think of using a nail. But what you most probably would do, would be to use the oldest mechanical principle known to man, the wedge.

What Invention Is

Brought down to its simplest terms, that is exactly what invention is—the combination of two ideas; a problem which must be solved and a fact of mechanics or science which solves the problem. That is the way every invention has been made. So, although you may never have thought of it in just this way, every time you solve some problem in your daily life—at home, traveling, or in business—you are an inventor; you use the principles of thought and action which govern the Science of Invention!

You can see, therefore, how easy it is for you to develop your natural instinct to "fix things." The same processes of thought that almost instinctively told you to fix a rattling window with a wedge can be so well developed that you can learn to invent other things almost as easily and quickly. You know, too, that every invention is made only by thinking inventively. And every inventor is agreed that the principles of Inventive Science are so simple, so easy to learn that any one, regardless of training or education, can develop himself to become a successful inventor!

Edison Says: "Invention Should Be Taught as a Science!"

But, although the fact has been universally recognized, that invention is governed by a few simple, easily acquired, fundamental principles, no one ever thought of putting these principles in black and white so that everybody interested in invention could read them. In spite of the fact that Thomas A. Edison made his famous statement that invention should be taught as a science, thousands of people continued to work blindly, doggedly, haphazardly to perfect their ideas.

But now you can learn how to invent. Fifteen famous inventors have at last given to the world the laws and principles of Inventive Science. They have shown every ambitious man and woman how to invent. They are teaching invention, exactly as other people are teaching law, medicine, bookkeeping. Instead of spending years groping blindly, instead of wasting your time in useless, heartbreaking drudgery, you learn how to complete your ideas quickly; you learn how to think so you are sure to succeed.

One Little Idea May Bring You a Fortune

With every new advance, with every new discovery that the world experiences more problems are coming up—and more inventions are needed to solve these problems. Now, as never before are new inventions wanted, and the world will pay a fortune to the man or woman who gives it just one of the inventions it needs now.

But all inventions need not be enormously big. Little ideas will bring you returns equally as great. Eberhard who invented the rubber on the end of a pencil, has been paid hundreds of thousands of dollars for his simple idea. The man who invented the metal tip for shoelaces, the man who conceived the idea of the "humped" hairpin, the man who developed the metal tape measure; all have achieved success and wealth as great or greater than the inventors of large machinery.



Little inventions like these have brought fortunes to their inventors

Ideas for Inventions Everywhere

Whatever your position in life, whatever kind of work you do, you are constantly meeting problems which must be solved. Even so small an idea as a new kind of kitchen knife for your wife may prove to be the making of your fortune. As an office worker you may invent some little method which will simplify work, or if you live on a farm, you can invent some idea to meet one of your every-day needs.

The work you do, the life you lead, the problems you meet, all present you with innumerable opportunities to invent things. All you need is the ability to think inventively—to train your mind to connect two ideas—just as you connected the ideas of the rattling window and the wedge—and you can be assured of success.

Learn How to Invent at Home

Take advantage of the opportunity offered you now. Get the advice and the help of the fifteen famous inventors who tell you all the secrets of invention. Learn how to develop your ideas so they will make money for you.

This is the first course in practical invention that has ever been devised. In simple, easy-to-understand language you are told how successful inventors work; you learn how to think along inventive lines, you learn the short-cuts to successful invention; you learn how to use the secrets of invention that convert a simple little idea into money.

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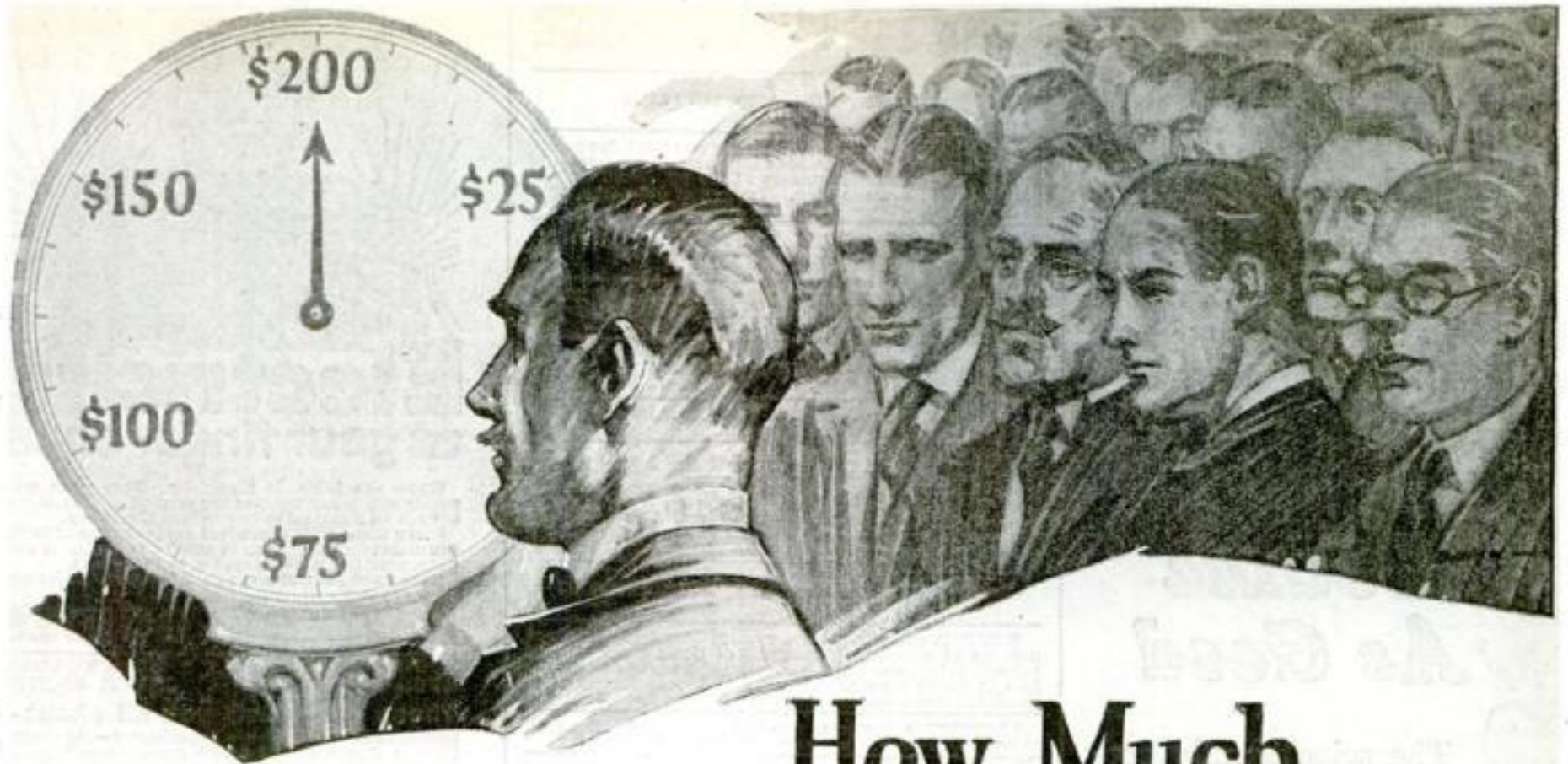
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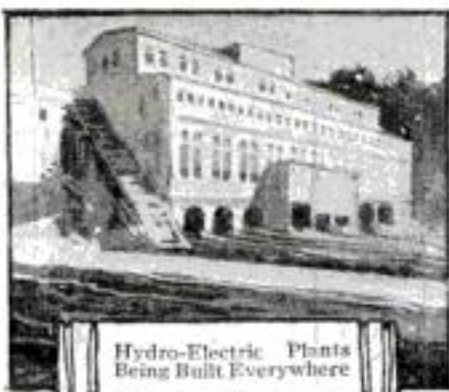
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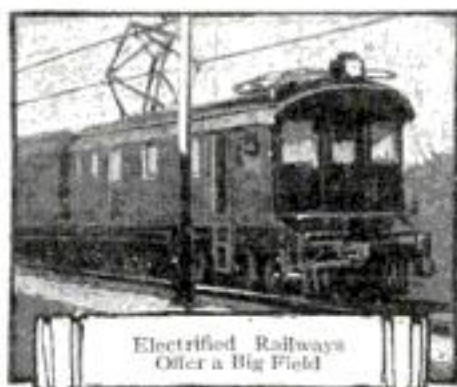


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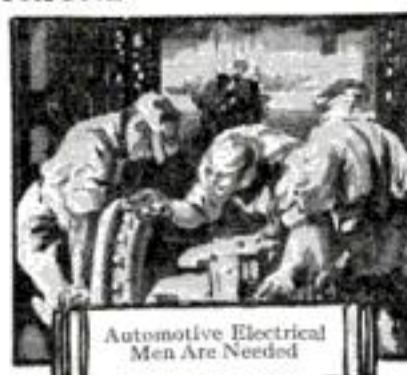
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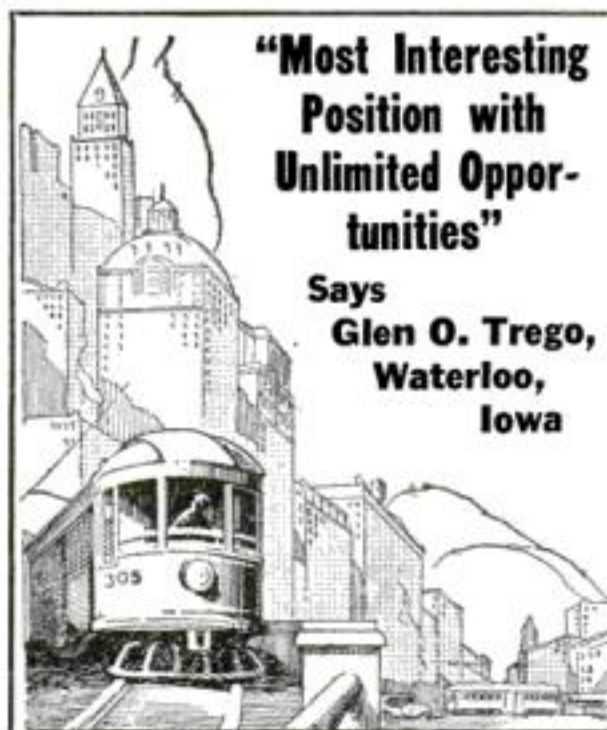
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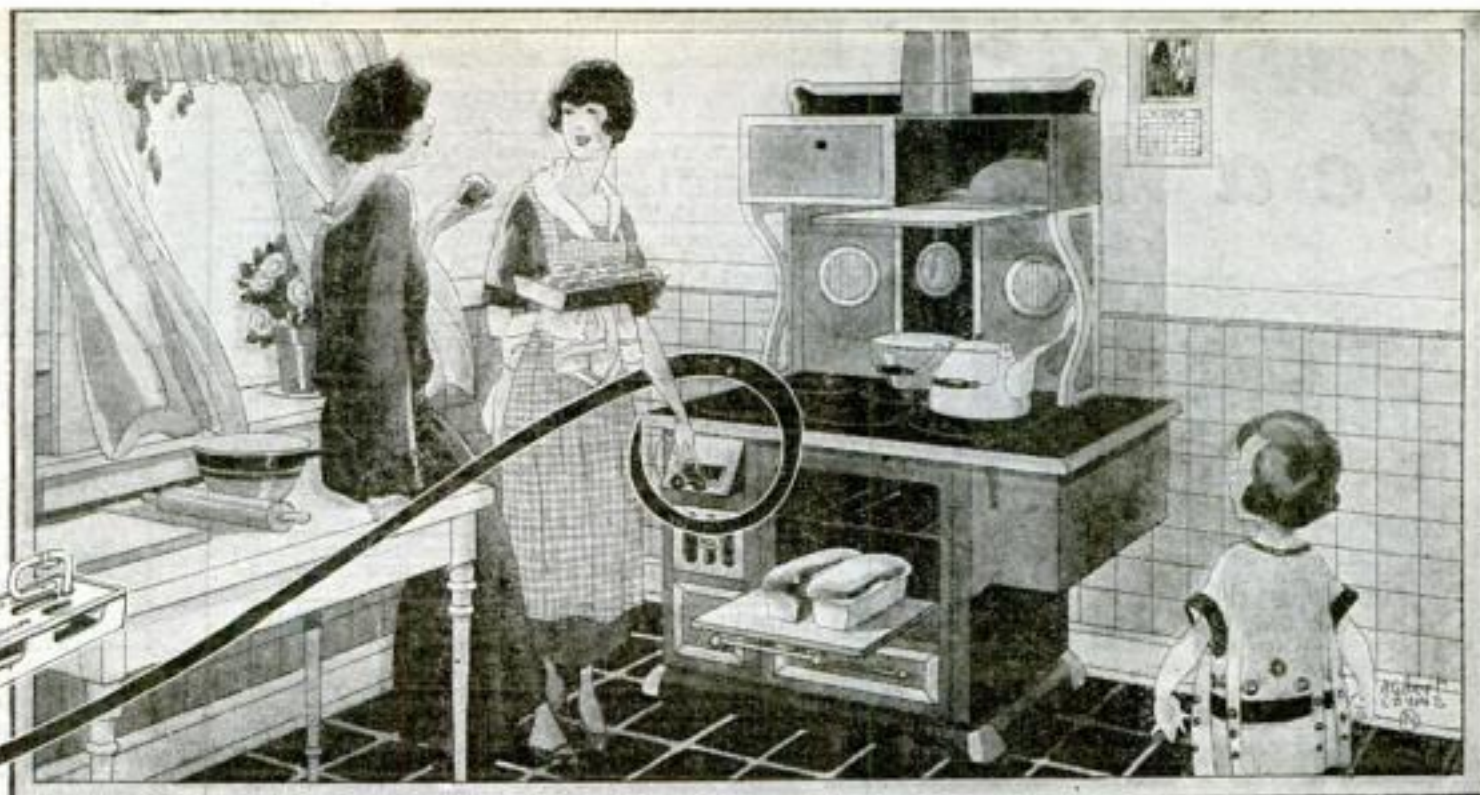
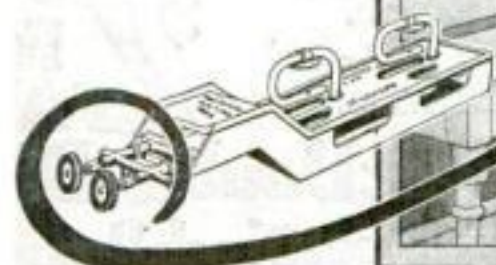
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I want men and women of every type. If you want to earn \$40 to \$50 a week in spare time, write me. If you can give all your time as a salesman and want \$200 to \$250 a week, write me. If you can swing a whole territory and want \$5,000 to \$15,000 a year, wire me at my expense for sales plan and how you can get an exclusive franchise for your territory. But act at once if you want to "cash in" on this great new fuel idea.

OLIVER GIVES FORDS AWAY

The big Summer season is just starting. I give Fords to producers. No contest. Act at once.

Write today for sales plan and free book "New Kind of Heat," address me personally B. M. Oliver, Pres. 2007-D Oliver Building, St. Louis, Mo.

No More Sweltering Kitchens in Summer—No More Fires to Build, Bank or Watch—No More Dirty, Heavy Coal to Lift—No More Clouds of Ashes to Breathe or Back-breaking Scuttles to Empty—No More Fine Ashes and Dust Over the Furniture—No More Smelly, Sooty, Oil Stoves and Disease Breeding Scuttles to Clutter Kitchen. No More Spoiled Roasts, Bread or Cake—High Prices—No More Slavery to a Red Hot Kitchen Stove.

HERE is the amazing new invention that has ended forever the days of woman's slavery to all kinds of household drudgery. Here is the wonderful device that—in one minute—makes your present coal and wood range into a *real gas stove that turns on and off with a valve*. Gives you much or little heat—only when you want it—and at the simple twist of your wrist.

Wonderful Baking and Cooking

With this marvelous invention you bake in your good old oven—better and quicker than you ever baked before. Suppose you want a batch of bread or biscuits. You want a light fluffy cake or some pies. Do you waste fuel keeping a hot fire going in your stove all day long just to cook a few meals or do a little baking? Do you chop wood, build a smoky dirty fire, carry coal and wait for the oven to heat up? Then swelter and sweat in a roasting hot kitchen for hours trying to keep the oven at even temperature? Or do you fuss around with a makeshift oven on a smelly, sooty oil stove that clutters up the kitchen? No!

Just Turn a Valve

With this wonderful invention in your stove you simply turn a valve, strike a match and light your fire! In a jiffy the oven is at a fine even temperature—any degree you want. Put in your roast or baking. Put on your stew or vegetables. Go away and forget them. Come back when they are done, turn the fire off—just turn the valve—and leave your kitchen cool and sweet.

Burns 95 % Air—5 % Oil

Mr. Oliver calls his invention the Oliver Oil-Gas Burner because it uses 95% air and 5% coal oil (ordinary kerosene, the cheapest fuel there is) turning them into an actual gas that burns with an intensely hot, clean flame. No wicks, no smoke, no odor.

Fits All Stoves

Mr. Oliver's wonderful invention—made in sixteen models—fits any kind of cook stove or range. No holes to drill, no bolts to fasten, no changes to make. Simply sets in firebox in one minute. Absolutely safe. It lasts a lifetime. Every day hundreds of letters pour in from grateful women telling how the Oliver has relieved them from the drudgery and heat of Summer kitchens. Mother M. Burchmans of Missouri writes, "The Oliver burner cooks and bakes beautifully. I wish you could see the beautiful brown well-baked bread, cakes and pies." Mrs. C. H. Schmidt of St. Louis says, "My bread and cake are like pictures." S. Summerrow of Texas says, "I am kissing coal and wood good-by. Don't know how to thank you for the wonderful Oliver gas." F. H. Horton, North Dakota, writes, "Oliver is what I call a blessing. You couldn't buy it back for \$50. My wife baked bread with only one burner going." John Orantz of Minnesota says, "The Oliver is just the thing for Summer use."

30 DAYS'

But you don't have to be satisfied with reading about the Oliver. You can test it for 30 days—you can use it in your own home—bake with it in your own oven—and see how miraculously it does away with sweltering kitchens and the dirt, mess and drudgery of coal and wood—on Mr. Oliver's Free Trial Offer.

Send immediately for the attractive Free booklet "New Kind of Heat" telling all about this amazing new invention. If you mail the coupon at once you will be in time to receive Mr. Oliver's Special Low Introductory Price, and 30-day Free Trial Offer. Already the big Summer demand for Oliver's is increasing. Our big factory is working night and day to fill orders—but we can still guarantee delivery if you will hurry. The illustrated book is free. Send no money and don't pay postman a cent. There is no obligation whatever. But fill in and mail the coupon now before you turn this page.

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Burners in the World
2007-D Oliver Bldg., St. Louis, Mo.

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Oliver Oil-Gas Burner & Machine Co.,
2007-D Oliver Bldg., St. Louis, Mo.

Send your Free Book, "New Kind of Heat" and also your special low price and 30-day Free Trial offer. This does not obligate me in any way.

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BEFORE or after filing application for patent on your invention it will pay you to read over my "Inventor's Adviser No. 1," free on asking. M. Labiner, Registered Patent Attorney, 2 Park Row, New York.

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PATENTS—Before disclosing an invention the inventor should write for our blank form "Record of Invention." This should be signed, witnessed and returned to us together with model or sketch and description of the invention and we will give our opinion as to its patentable nature free. Our Three Books mailed free to inventors. Our Illustrated Guide Book, "How to Obtain a Patent," contains full instructions regarding patents. "List of Patent Buyers" sent free, contains unsolicited letters from manufacturers and others who are constantly writing us regarding the purchase or leasing of meritorious patents. We have recently received a number of requests among which are the following: 45 requests for Miscellaneous Articles in all classes of invention, too numerous to mention. 14 requests for Household Novelties and Specialties. 11 requests for General Novelties and Mail Order Articles. 6 requests for Automobile Accessories and Specialties. 3 requests for Small Metal Articles and Metal Specialties. 2 requests for Radio Accessories and Equipment. 1 request for Amusement Apparatus. 1 request for Refrigerators. 1 request for Tractors and Similar Machines. 1 request for Farmers' Supplies. 1 request for Games. 1 request for Toys. We endeavor to assist our clients in the commercial development of their inventions. Owing to the growth of our business we have established for the benefit of our clients, Branch Offices in New York City at 1007 Woolworth Bldg., Philadelphia at 714 Liberty Bldg., Pittsburgh, Pa., at 524 Empire Bldg., Chicago, Ill., at 1114 Tacoma Bldg., and San Francisco, Calif., at 1010 Hobart Bldg. Victor J. Evans & Co., Main Offices, 148 Ninth, Washington, D. C.

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RADIO has jumped into the front rank of the world's great industries. In its colossal growth it has swept across the face of the earth. The shores of every continent are dotted with Radio stations. Nearly every vessel on the seven seas is a floating Radio station. Thousands of factories are busy day and night supplying the tremendous demand for equipment and apparatus. Every night millions of people "listen in" to Radio broadcast news, music, entertainment and education.

Radio operators on swift ocean greyhounds are traveling the world over, visiting famous scenes, enjoying a wonderful life of romance and adventure—and at the same time getting a splendid salary. At land and broadcasting stations, operators, aids, specialists are doing this new and interesting work—and making big money doing it. Under their fingers flows the story of the world's progress. To them comes news from far-off countries speeding through the skies. Factories, stores, laboratories, banks, cities, business houses, newspapers and schools are employing Certified Radio-tricians as operators, maintenance, repair and installation experts, engineers, technicians, aids, designers, demonstrators, salesmen, instructors.

Yet Radio is only in its infancy. Despite the marvelous advances of the last few years we are only on the threshold of the Radio era. We have barely scratched the surface of its vast possibilities. We have merely

guessed its yet undiscovered wonders! Great as Radio is today

it will be a thousand times greater tomorrow! The man who gets into Radio today—who prepares NOW to grow up with this wonderful new science—will have a great share in its glorious future. He will be able to win fame, honor and wealth in this fascinating profession.

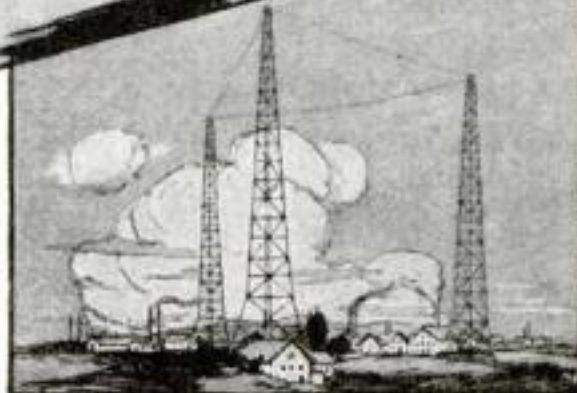
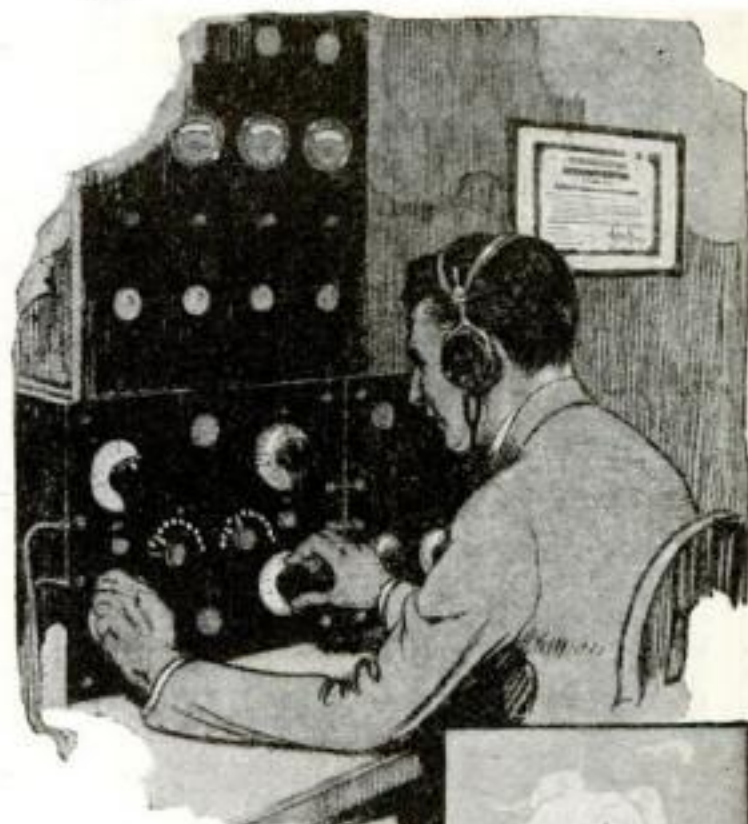
How You Can Qualify at Home for a Fine Radio Position

For the ambitious man, Radio offers greater opportunities for success than any other profession or trade. No matter what your ambition, no matter what your education or your ability, there is a special field in Radio where your natural talents will bring you a wonderful position, doing easy, interesting work at a fine salary; where your success is almost certain.

The National Radio Institute, known the world over as the oldest and largest Radio Training Organization, will prepare you quickly in your spare time at home to qualify for the position you want. Hundreds of our graduates are today reaping big returns from their instruction. Some of them are radio inspectors and engineers. Others are in charge of land and sea stations. Still others are in charge of radio departments in stores or are in business for themselves. But no matter in what special field they have gone, all of them are earning more money than they ever made before.

See in the panel at the left how much a few of our graduates are making in REAL MONEY. Most of these men, when they started our course, knew little or nothing about Radio. Yet, in a few short months, our instruction qualified them to earn big money as Certified Radio-tricians. The same instruction, the same help that brought quick success to these men, is now offered to you. You have the same opportunities, you have the same prospect they had. Take advantage of them.

In the panel on the left are just a few of the positions open to the Certified Radio-trician. Thousands of splendid big-paying positions are going begging for want of men able to handle them. Get into Radio Now. Grow up with it. Advance with it.



Special Opportunity Now Open

The urgent need for radio experts and the calls which come to us for our students prompt us to make a special offer open to new students for a limited time. Through this special offer your enrollment will be accepted at a special rate, and you will receive, without extra cost, our new course in Wireless Telephony.

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We have just prepared a new book which is filled with the latest information about the wonderful opportunities in this newest and fastest growing profession. It will be sent to you absolutely free. Send for this book. It will tell you all about how we prepare you for, and help you to get or secure the wonderful positions open in this fascinating field. Send for this free book today.

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What Some of Our Graduates Earn

Leo. A. Goldblatt, as ship operator and clerk, averages \$165 a month.

Revere B. Gurley, another graduate, is getting \$7.00 a day as inspector in a radio factory.

R. D. Kimmel is earning big money as a Radio Salesman.

K. R. Bloomer has become an inventor of Radio equipment.

Frederick H. Greening is in the Radio Department of the Telephone Maintenance Company of Chicago.

Thomas E. Lepson operates the Broadcasting Station at Washington, D. C.

James F. Nicholls is Radio Instructor at the Walter Reed Government Hospital and is paid \$150 a month and all expenses.

Edwin L. Powell, Expert Radio Aid at the Washington Navy Yard, earning a handsome salary.

J. Webster Stevens, an electrician, works at night as a Certified Radio-trician installing sets, repairing, etc. Averages \$150 a month in his spare time.

Pick Out the Job You Want We Will Help You Get It

This is a brief list of the positions in the Radio field today, and the salaries paid.
Radio Mechanic, \$1,500 to \$2,000 a year.
Radio Inspector, \$1,800 to \$3,000 a year.
Radio Auditor, \$1,200 to \$1,800 a year.
Radio Salesman, \$2,000 to \$5,000 a year.
Radio Engineer, \$3,500 a year and up.
Radio Executives, up to \$10,000 a year.
Radio Instructor, \$100 to \$150 a month.
Radio Aid, \$6 to \$10 a day.
Radio Draftsman, \$7 to \$10 a day.
First Class Ship Operator, \$105 a month, all expenses paid.
Second Class Ship Operator, \$95 a month, all expenses paid.
Third Class Operator, \$85 a month, all expenses paid.
Commercial Land Station Operator, \$150 a month and up.
Broadcasting Station Operator, \$125 to \$250 a month.

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\$80 Drafting Course Free

There is such an urgent demand for practical, trained Draftsmen that I am making this special offer in order to enable deserving, ambitious and bright men to get into this line of work. I will teach you to become a Draftsman and Designer, until you are drawing a salary up to \$250 a month. You need not pay me for my personal instruction or for the complete set of instruments.

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Free Course Offer Coupon

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MAKE \$25 to \$50 week representing Clows' Famous Philadelphia Hosiery, direct from mill—for men, women, children. Every pair guaranteed. Prices that win. Free book "How to Start" tells the story. George Clows Company, Desk 24, Philadelphia, Pennsylvania.

WE start you without a dollar. Soaps, extracts, perfumes, toilet goods. Experience unnecessary. Carnation Co., Dept. 21, St. Louis.

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AGENTS, Big Profits, selling Wubrub Polish for furniture, woodwork, automobiles, etc. Cleans and polishes. Write for Big Free Offer. Fritch's Laboratories, 312-E North Carpenter, Chicago.

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27,000 records guaranteed with one Everplay Phonograph Needle: new, different, cannot injure records. \$10.00 daily easy. Free sample to workers. Everplay, Desk 415, McClurg Bldg., Chicago.

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MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

\$60-\$200 week. Free samples gold letters for store windows. Easily applied. Liberal offer to general agents. Metalfine Letter Co., 434 North Clark, Chicago.

BIG money and fast sales. Every owner buys gold initials for his auto. You charge \$1.50; make \$1.35. Ten orders daily easy. Write for particulars and free samples. American Monogram Co., Dept. 47, East Orange, New Jersey.

SELL necessities. Everybody needs and buys the "Business Guide." Bryant cleared \$800 in July. Send for sample. It's free. Nichols Company, Box 115, Naperville, Illinois.

WHY work for others? Make and sell your own goods. We show you how. Enormous profits. Write quick for free book explaining everything. National Scientific Laboratories, 213 North Monroe, Richmond, Virginia.

MAKE \$31.00 profit with only \$1.50, selling gold leaf monograms for automobiles, trunks, bags, window and wagon letters. Applied instantly. Experience unnecessary. Outfit brings \$32.50—costs \$1.50—you make \$31.00 profit. Free samples (36 designs). NuLife Auto (B) Aid, Hartford, Connecticut.

"DENGEMO" vibrating portraits, increase your profits. Year around. 50c postpaid. Tecart Studio, 335, Station C, Los Angeles, California.

MAKE big money selling delicious puddings, polishing cloth, stain remover, 100 other tip-top sellers. Equipment free. Write Newton Co., 14 Main, Newark, New York.

EASY, pleasant work for mechanics, shop men, clerks during spare hours, will add many dollars to their salaries. Also want persons who can give full time. Big wages assured. Novelty Cutlery Company, 27 Bar Street, Canton, Ohio.

GET our plan for monogramming automobiles, trucks; hand luggage and all similar articles by transfer method, experience unnecessary; exceptional profits. Motorists' Accessories Company, Mansfield, Ohio.

WE TEACH COMMERCIAL ART

Meyer Both Company, the largest Commercial Art Organization in the World, offers you an unusual opportunity for practical training. If you like to draw develop your talent. Study this practical course—taught by the nationally known Meyer Both Company, with twenty-two years success—who each year produces and sells to advertisers over 15,000 commercial drawings. Our teachers give you the double advantage of being instructors of proven ability, as well as artists in this widely known organization. Meyer Both instruction is the difference between successful fact and experimental theory. Commercial Art is a highly paid, intensely interesting profession, equally open to men and women. Home study instruction.

Get Facts Before You Enroll in any School.

Ask the Advertising Manager of the leading newspapers in your city, anywhere in the United States, Canada, England or Australia, about the Meyer Both Company—let them tell you about us. Write for our illustrated book "YOUR OPPORTUNITY"—for one-half the cost of mailing—four cents in stamps.

MEYER BOTH COMPANY

Department of Art Instruction

Michigan Ave. at 20th St., Dept. 35 CHICAGO, ILL.

NOTE—To Art and Engraving Firms: Secure practical artists among our graduates. Write us.

A PRACTICAL EDUCATION IN ELECTRICITY

Learn by the thorough approved scientific methods which our seventeen years of experience enable us to give you A. C. and D. C. Armature Winding, Wiring and Testing, Fractional Electricity, Drafting, Electrotechnics, Commercial Engineering, Electrical Engineering with U. S. Degree. "Earn While You Learn." Radio Broadcasting WIAO every day. Eighteenth year opens April 2nd. Write for Illustrated Catalog. It's Free. Mention age, education and course interested in. **SCHOOL OF ENGINEERING OF MILWAUKEE** 415 Marshall St. Div. 23 Milwaukee, Wis.

SPEECH DEFECTS

A private residential institute for the correction of Stammering, Stuttering, Lipping, Loss of Voice, Monotone Pitch, Attention Deafness and for those retarded in school because of cognate defects. Conducted by

DR. FREDERICK MARTIN
(himself once a confirmed stammerer)

Lecturer, Post Graduate Medical College and Hospital, New York City—Formerly Director of Speech Improvement, Board of Education, New York City.

Normal courses for Teachers of Speech Improvement. **MARTIN INSTITUTE FOR SPEECH CORRECTION** 418 DeWitt Park, Ithaca, N. Y.



Begin Today—Write for My FREE BOOK
I can make a good penny of you at home during spare time. Write for my book "HOW TO BECOME A GOOD PENMAN." It contains specimens and tells how others mastered penmanship by the Tamblin System. Your name will be elegantly written on a card if you enclose stamp to pay postage. FREE BOOK—Write for it today.

F. W. Tamblin, 417 Ridge Bldg., Kansas City, U. S. A.

High School Course in Two Years

Lack of High School training bars you from a successful business career. This simplified and complete High School Course—especially prepared for home study by leading professors—meets all requirements for entrance to college and the leading professions.

30 Other Courses No matter what your business inclinations may be, you can't hope to succeed without specialized training. Let us give you the practical training you need. Check and mail Coupon for Free Bulletin.

American School
Drexel Ave. and 58th St.
Dept. H-475 Chicago

American School Dept. H-475 Drexel Ave. and 58th St., Chicago
Send me full information on the subject checked and how you will help me win success.

- | | |
|-------------------------------|-----------------------------|
|Architect |Lawyer |
|Building Contractor |Machine Shop Practice |
|Automobile Engineer |Photoplay Writer |
|Automobile Repairman |Mechanical Engineer |
|Civil Engineer |Shop Superintendent |
|Structural Engineer |Employment Manager |
|Business Manager |Steam Engineer |
|Cert. Public Accountant |Foremanship |
|Accountant and Auditor |Sanitary Engineer |
|Bookkeeper |Surveyor (and Mapping) |
|Draftsman and Designer |Telephone Engineer |
|Electrical Engineer |Telegraph Engineer |
|Electric Light and Power |High School Graduate |
|General Education |Fire Insurance Expert |
|Vocational Guidance |Wireless Radio |
|Business Law |Undecided |

Name _____
Address _____

Money Making Opportunities

ONLY one sale a day means \$200 per month! Five sales \$1,000 per month. Marvelous new adding machine. Retail \$15.00. Work equals \$350 machine. Adds, subtracts, multiplies, divides automatically. Speedy, accurate, durable, handsome. Five year guarantee. Offices, stores, factories, garages buy one to dozen. A fortune for live agents. Write quick for protected territory and free trial offer. Lightning Calculator Co., Dept. P, Grand Rapids, Michigan.

\$5 to \$15 daily easy—Introducing New Style Guaranteed Hosiery. Must wear or replaced free. No capital or experience required. Just show samples, write orders. We deliver and collect. Your pay in advance. Elegant outfit furnished all colors and grades including silks. Mac-O-Chee Mills Co., Desk 1524, Cincinnati, Ohio.

WANTED—District purchasing agents, experience unnecessary. National Instrument Co., 4707 North Hamilton, Chicago.

SELL wall emblems. Every lodge member wants one. Big money—all or spare time. Free sample and cash bonus plan. Kier Emblem Co., Dept. P.S.3, 538 So. Clark, Chicago.

WONDERFUL discovery. Charges batteries in ten minutes. Gallon free to agents. Radiolite Co., St. Paul, Minnesota.

POLMET polishing cloth cleans all metals; sells fast at 25c. Sample free. F. C. Gale, 15 Edinboro St., Boston.

HANDKERCHIEFS—"Kwaliti" line, standard grades. Bedrock factory prices to agent. Get into this solid dependable business. Turnover Co., 181 East 17th St., New York.

SALESMEN sell long range, low price radio receiving sets \$10.00 monthly payments. No investment, we finance responsible district representatives. Ten sales monthly assures you \$350.00 steady monthly income. Every home a prospect. Our plan is sweeping the country. Don't wait to write; telegraph, giving references. Ozarka Radio, 6342 North Clark Street, Chicago.

MAKE money silvering mirrors, all kinds plating, knives, spoons, auto headlights. Outfits furnished. Free booklet. International Laboratories, Dept. 27, 311 Fifth Avenue, New York.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

AGENTS—I pay \$1.25 an hour all or part time. Nineteen full-sized packages right out of stock. Carrying case, advertising matter, booklets, everything needed free. Pay starts when outfit arrives. Write quick for free offer. Dept. A-14, Harley Company, Dayton, Ohio.

MAKE big money spare time or full time. No capital or experience required. New, wonderful product. "Old Master" Automobile Enameling Outfit. Paint car today—drive it tomorrow. Beautiful, durable factory-like lustre. Exclusive territory. Sample showing finish and quality sent free. Akron Paint Products Company, Akron, Ohio.

\$10 DAILY silvering mirrors, plating and refinishing lamps, reflectors, autos, beds, chandeliers by new method. Outfits furnished. Write Gunmetal Co., Ave. F., Decatur, Illinois.

WONDERFULLY Successful Product. Sells to 2 out of every 3 homes—by actual test. Absolutely prevents moth damage for one year. The only odorless, stainless, non-inflammable moth preventive. Guaranteed by a Money-Back Bond. U. S. Government reports are making it big seller all year round. Produced by big reliable company which co-operates with both local and national advertising. Easily sold. Sales average \$1.25 upward. 100 per cent profit. Hundreds of enthusiastic salesmen making good. Get yourself in line now for big spring business. Every home, hotel, club, institution, mill, business concern must use it for protection. Saves many times its cost every year. Nothing else like it. In use 25 years—now available to everyone. Write at once for territory. Mott K-L Company, Inc., Suite 1101-1119 Flatiron Bldg., New York.

BIG MONEY IN SPARE TIME for one man in each locality making embossed show cards and price tickets for stores and others. Easy, quick work. No training needed. New embossing machine does it all. 400% profit. Signs sell on sight. T. W. Cushing of Chicago sold \$75 first call. S. D. Downes averaged \$15 a day for 6 months. Many sell \$5 to \$20 daily. No speculation. Before you invest a penny we send you free sample cards to show merchants and convince yourself they sell at sight. Write today. Praxair Corporation of America, Dept. 400, Geneva, New York.

AGENTS—Mason sold 18 Comet Sprayers and Auto-washers one Saturday. Profits \$2.50 each. Particulars free. Established 30 years. Rusler Co., Johnstown, Ohio. Dept. 30-A.

SUCCESSFUL salesmen! Tie in with Alexander Motion Picture Publicity Service! We want salesmen of fighting stock—men who can take punishment smilingly—to sell a real service to real business men. Our intensive sales training course and sales plan will help you to qualify. This fascinating work is paying as much as \$25,000 yearly. Will you exchange a postal for details—now? Alexander Film Co., 1141 Main, Spokane, Washington.

AGENTS—\$75-\$100 weekly taking orders for popular \$3.98 raincoats. Commissions advanced. We deliver and collect. Free costs to workers. Eagle Raincoat Co., 419 Lees Building, Chicago.

FREE Book—Start little Mail Order business. Home employment evenings. Pier, Dept. 179-A, 74 Cortland Street, New York.

BIG profits. New \$3.50 automatic adding machine. Wonderful seller. No competition. Bassett Company, 1455-P Hollywood Ave., Chicago.

HERE'S a business requires only table room. We start and help build business. Work for us painting landscape photo print pictures. No experience. We furnish outfit. Free literature. Tangle Co., 191 Main, Muscatine, Iowa.

AGENTS' profits amazing. Remarkable new invention. Saves every pig in litter. Every farmer or hog-breeder buys dozen to hundreds. Exclusive territory. Sales Mgr., 17 Sta. C, Omaha, Neb.

TRAVELING salesmen to take small side line boxed assortments, Birthday, Christmas Cards, etc., to sell dealers. Liberal commission. Attractive samples furnished. State territory covered. W. A. Wilde Co., 9 So. Clinton Street, Chicago.

FIFTY-SEVEN Miles Per Gallon made with new patented Gasoline Vaporizer. Write us for particulars. Stransky Mfg. Co., Department C, Pukwana, South Dakota.

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Why Hesitate? **ACT NOW!**

STATION: JANUARY
"CAR FOR EVERY FAMILY" IS THIS MAKER'S SLOGAN
See Closed Car on a Road of Open.

48 BLACKSMITH SHOP GROWS INTO \$2,000,000 FIRM
The success of this firm is a story of the power of the automobile industry.

BANKERS VIEW SHOW STABILITY OF MOTOR TRADE
Once Chary of Dealers, Now Welcome Them, as Showing a Healthy and Growing Industry.

43,000 DEALERS, 48,000 PUBLIC GARAGES IN U.S.
The growth of the automobile industry is evident in the number of dealers and public garages.

ENDLESS MARKET OPENING BEFORE MOTOR INDUSTRY
BY A. E. HARRY, President of the American Motor Vehicle Association.

\$2,750,000,000 TRADE PUTS AUTO INDUSTRY FIRST
Figures Show Year Totals for Year.

11,500,000 MOTOR VEHICLES ON U.S. REGISTRY LIST
The growth of the automobile industry is evident in the number of vehicles on the registry list.

PROBABLE SALES OF 1923 PUT AT 2,750,000 CARS
Trade Leader Says Hope Output This Year.

2,627,000 CARS BUILT IN U.S. IN 1922
Production in 1922 of 2,627,000 automobiles produced by the industry.

Leaders of Automotive Trade See 1923 as Greatest Year
The year 1923 is expected to be the greatest year for the automotive trade.

Ambu Engineering Institute
2632 PRAIRIE AVE. — TELEPHONE CALUMET 0025-26-27

WANTED!

Men Who Know Automotive Electricity

One of the leading carburetor manufacturers, located in the city of Chicago, has changed his sales policy and is selling and servicing his carburetor through his own service stations. He has 1500 such service stations now and intends to establish 1000 more.

The men who service his carburetor must be trained in Automotive Electricity, as well as in all carburetor construction, and he has requested the AMBU Engineering Institute to secure for him the necessary men and train them in Automotive Electricity. He will then give them training at his factory on his carburetor.

Unusual Opportunity, Insuring Big Money, Steady Work

To those men who want to take advantage of this opportunity and can qualify by putting in eight weeks at Chicago of intensive training, we will gladly send further information, without obligation. Sign the coupon below and mail today.

Instruction limited to 20 men at a time. Classes start every other MONDAY beginning February 12th. Successful ones will be those that act promptly.

Offer is open to employees, as well as owners of shops.

AMBU trained men are holding successful positions all over the country.

Those who want this training and are unable to come to Chicago can have the instruction in Automotive Electricity at home. Use the coupon.

Ambu Engineering Institute

C. J. Buckwalter
President

2632 Prairie Avenue

Dept. 44 Chicago, Illinois

AMBU ENGINEERING INSTITUTE,
Dept. 44, 2632 Prairie Ave., Chicago

I want to know more about the opportunity for making big money—quick—that awaits me in the rich new field of Automotive Electricity. Send me free booklet and complete information. I am interested in learning (at Chicago) (at home).

Name

Address

City

"STAMMERING"

Its Cause and Cure

You can be quickly cured if you stammer. Send 10 cents, coin or stamps, for 288 page cloth bound book on Stammering and Stuttering. It tells how I cured myself after Stammering and Stuttering for 20 years. BENJAMIN N. BOGUE, 692 Bogue Bldg., 1147 N. 3rd St., Indianapolis.

Stop Forgetting

Make Your Mind an Index from which you select facts, figures, names, faces. Develop concentration, self-control, overcome bashfulness, forgetfulness. Write today for FREE memory and concentration test and illustrated booklet. "How to Remember." PROF. HENRY DICKSON, Dept. 929 Evanston, Ill.



WANTED!
U.S. RAILWAY
MAIL
CLERKS

TRAVEL—SEE YOUR COUNTRY
STEADY WORK—NO LAYOFFS—PAID VACATIONS
Common Education Sufficient
Influence Unnecessary

Get \$1600 to \$2300 a Year

MEN—BOYS 18 OR OVER
SHOULD MAIL COUPON
IMMEDIATELY

Franklin Institute, Dept. P 279, Rochester, N.Y.
Sirs: Send me without charge (1) sample Railway Mail Clerk Examination questions; (2) tell me how I can get a U. S. Government job; (3) Send list of Government jobs obtainable.

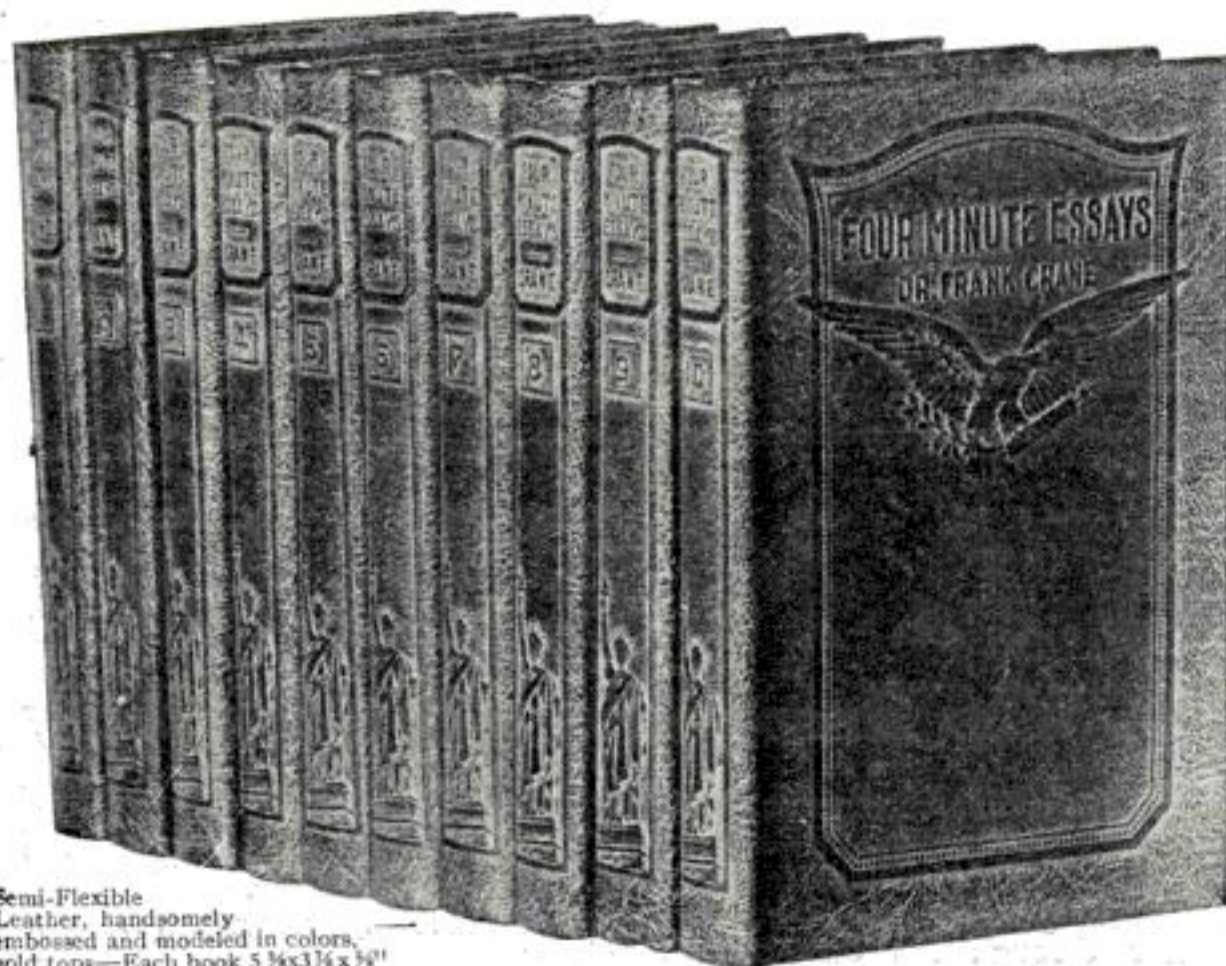
Name

Address

Four-Minute Essays by Dr. Frank Crane

of whom SID SAYS:

"He is the doggondest combination I ever saw of the idealist and the practical man. His head is sometimes in the clouds, but his feet are always on the ground."



Semi-Flexible
Leather, handsomely
embossed and modeled in colors,
gold tops—Each book 5 3/4 x 3 1/4 x 3/4"

THE MAN WITH A MILLION FRIENDS

Dr. Frank Crane was not known outside of a small circle of friends ten years ago when he began writing for one daily newspaper.

To-day 50 of the great metropolitan papers publish his daily messages which are read by millions of men and women who are doing the world's work.

In a decade he has won a million friends through his helpful philosophy.

Here are 400 of his Four-Minute Essays—his masterpieces—selected by Dr. Crane himself. Ten beautiful volumes, each small enough to be carried in your pocket and read on the train or in the car—in any place and at any time when you have four minutes to spare.

These are the cream of Dr. Crane's inspirational Essays of courage, good cheer and friendliness which will help you find joy in the commonplace things of life and open for you the doors to the great minds of all times.

FREE IF YOU ACT NOW
15 VOL. SHAKESPEARE, FULL LEATHER

To introduce this new edition of the Four-Minute Essays we will present to each purchaser, free, a 15-volume set of Shakespeare bound in full leather, embossed in gold, round corners, in an assortment of colors: brown, red, blue and gray. Our option on the Shakespeare is very limited so that orders must be placed immediately to take advantage of this special introductory offer.

SEND NO MONEY

Current Opinion, 48 & 50 West 47th St., New York

Please send me prepaid Dr. Crane's Four-Minute Essays, 10 vols., leather binding. I will either return the books in 10 days or send you \$1 as first payment and \$2 a month for 7 months. If I keep the Essays you are to send me 15 vols. of Shakespeare without additional charge.

Name.....

Address.....

P.S.M. 4-23

SHIPPED ON APPROVAL

We ship the Essays on 10 days' approval, charges paid. If you keep them you send us \$1 in 10 days and make 7 monthly payments of \$2 each, \$15 in all. Please mail coupon to-day that you may be early enough to get both sets of books for the price of the Essays alone.

CURRENT OPINION
NEW YORK CITY

Money Making Opportunities

AGENTS AND SALESMEN WANTED

YOU can manufacture these biggest selling specialties in your own home, office, shop, from Miller's Guaranteed Manufacturer's Formulas. Simple detailed instructions without machinery. Investment small. Stamp brings valuable information; to start on small scale manufacturing: 30-Minute Beauty Clay, Mexican Yucca Soap, Concentrated Vanilla, Launderite Washing Marvel, Laundry Specialties, Rubber Balloons, Amazon Rubber Tire Repair, Twenty Latest Automobile Specialties, Coconut Creme Custard; all latest Food Products, Beverages, Flavors. Many other specialties. Don't confound my reliable processes with the antiquated "junk" recipes, commonly offered at seemingly bargain prices. Play safe, deal with a chemist 26 years experience supplying the best. Highest references. Miller, Industrial Chemist, Tampa, Florida.

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AGENTS sell Harper's Ten Use Household Cleaning Set. Washes and dries windows, cleans walls, sweeps, scrubs, mops, and does five other things. Sells for only \$2.85. Over 100% profit. Free information, Harper Brush Works, 141 A St., Fairfield, Iowa.

MAKE easy money selling printing. No collecting or delivering. Advertisers, Station C-5, Milwaukee.

AGENTS—New discovery makes all jelly "jell." Big profits, constant repeater. Sample free. Joy-Jel Company, 804 Grand, St. Joseph, Mo.

HELP WANTED

OUR genuine gold window sign letters are an excellent money-making proposition for handy men. Slann Sign System, East Bethune Avenue, Detroit, Michigan.

MEN—Are 17 to 45. Experience unnecessary. Travel, make secret investigations, reports. Salaries, expense. American Foreign Detective Agency, 321, St. Louis.

SILVERING mirrors, French plate. Easily learned, immense profits. Plans free. Wear Mirror Works, Dept. 26, Excelsior Springs, Missouri.

WRITE photoplays: \$50 each. Experience unnecessary; details free to beginners. Producers' League, 194, St. Louis.

BE a detective. Excellent opportunity, good pay. Travel. Write C. T. Ludwig, 424 Westover Bldg., Kansas City, Missouri.

WANTED—Ambitious men to work at home. Entirely new business; local or mail order. Previous experience unnecessary. Ordinary man made \$15 day. Write immediately. Kraft, Box 896-PS, San Francisco, California.

BE a railway traffic inspector! \$110 to \$250 monthly expenses paid, after 3 months' spare-time study. Splendid opportunities. Position guaranteed or money refunded. Write for Free Booklet C-13. Standard Business Training Institute, Buffalo, New York.

MEN—Will you increase your earnings? Work at home evenings? Then write enclosing stamped addressed envelope. Normande H, 147 W. 23d Street, New York.

MEN, women, over 18, desiring Government positions \$1400 up, write immediately for full information. Chicago Civil Service College, B-70 Kerner Building, Chicago.

STOP daily grind. Start silvering mirrors, auto headlights, tableware, etc. Plans free. Clarence Sprinkle, Dept. 95, Marion, Indiana.

AMBITIOUS men, write today for attractive proposition, selling subscriptions to America's most popular automobile and sportsman's magazine. Quick sales. Big profits. Pleasant work. Digest Pub. Co., 9523 Butler Bldg., Cincinnati.

GOVERNMENT railway mail clerks start \$133 month; expenses paid. Spectimen examination questions free. Columbus Institute, N-2, Columbus, Ohio.

ALL men, women, boys, girls, 17 to 60, willing to accept government positions, \$117-\$190, traveling or stationary write Mr. Oment, 295 St. Louis, immediately.

BOYS—men—become auto-tractor-gas motor experts. Earn \$35 week up. Hundreds of opportunities this spring. Learn at home. Sample lessons free. Write immediately today. Franklin Institute, Dept. P406, Rochester, N. Y.

BE a finger print expert. Learn on easy payment plan. Write, Vigilant Identification Co., Mt. Vernon, Illinois.

HOTELS need trained men and women. Nation-wide demand for high-salaried men and women. Past experience unnecessary. We train you by mail and put you in touch with big opportunities. Big pay, fine living, interesting work, quick advancement, permanent. Write for Free Book "Your Big Opportunity." Lewis Hotel Training Schools, Suite 2742, Washington, D. C.

EARN \$10 daily silvering mirrors, plating and refinishing metalware, headlights, chandeliers, bedsteads. Outfits furnished. F. Dele Laboratories, 1133 Broadway, New York.

DETECTIVES earn big money. Excellent opportunity. Travel. Fascinating work. Experience unnecessary. Particulars free. Write, American Detective System, 1968 Broadway, New York.

MEN—women—18 up. Get U. S. Government jobs. \$1140-\$1800 year. Common education sufficient with our coaching. Sample lessons free. Franklin Institute, Dept. P 42, Rochester, New York.

FIREMEN, brakemen, baggagemen, sleeping car, train porters (colored): \$140-\$200. Experience unnecessary. 838 Railway Bureau, E. St. Louis, Illinois.

WORK WANTED

LET us make your jigs, patterns, special machinery, models, dies, tools, gears, etc. Rose Manufacturing Co., Box 496, Kalamazoo, Michigan.

HIGH grade manufacturer seeks tools or metal specialties to make. Will purchase patents, or manufacture on contract or royalty. F. V. Bogart, 715 Park Ave., Rockford Illinois.

DISTRIBUTORS WANTED

DISTRIBUTORS for the D. C. S. auto products. Box 63, Crawfordsville, Indiana.

INSECTS WANTED

WHY not spend Spring, Summer and Fall gathering butterflies, insects? I buy hundreds of kinds for collections. Some worth \$1 to \$7 each. Simple outdoor work with my instructions, pictures, price list. Get posted now. Send 10c (Not Stamps) for my Illustrated Prospectus. Mr. Sinclair, Dealer in Insects, Dept. 7, Ocean Park, Calif.

Money Making Opportunities

BUSINESS OPPORTUNITIES

USED correspondence courses sold, rented, and exchanged. List free. (Courses bought.) Lee Mountain, Pisgah, Alabama.

ADVERTISE. Country, town newspapers. Lists free. Fennel Company, Covington, Kentucky.

RESPONSIBLE corporation wants general sales managers to open branch office, manage salesmen. \$500 to \$1000 necessary; expenses allowed to Baltimore if you qualify. Address Manager, 603 N. Eutaw Street, Baltimore, Maryland.

EXPERT chemist will furnish Formula and Trade Secrets in all lines. Lists free. W. L. Cummings, Ph. D., Gordon Avenue, Syracuse, New York.

ENTER a new business. Earn \$3,000 to \$6,000 yearly in professional fees making and fitting a foot specialty; openings everywhere with all the trade you can attend to; easily learned by any one at home in a few weeks, at small expense; no further capital required; no goods to buy, job hunting, soliciting or agency. Address Stephenson Laboratory, 15 Back Bay, Boston, Massachusetts.

WE start in business, furnishing everything. Men and women, \$30.00 to \$100.00 weekly, operating our "New System Specialty Candy Factories" anywhere. Opportunity lifetime. Booklet free. H. Ragsdale Company, East Orange, New Jersey.

SELL by mail. Big profit opportunities free. Harvey Teeple, Decatur, Indiana.

GET into the specialty manufacturing business. Amazing profits. We will send you free book explaining our system. Write immediately. A wonderful opportunity awaits you. National Scientific Laboratories, 213 North Monroe, Richmond, Virginia.

PATENTS procured—Trade marks registered—A comprehensive, experienced, prompt service for the protection and development of your ideas. Preliminary advice gladly furnished without charge. Booklet of information and form for disclosing idea free on request. Richard B. Owen, 44 Owen Building, Washington, D. C., or 2276-Z Woolworth Building, New York.

MAKE money with your camera. E. Lancaster, Box 967, Los Angeles.

FIFTY "Ideal" sidelines for mail dealers and salesmen. 500% profit. N. Home, 1957 Warren, Chicago.

\$50 to \$100 weekly profits secured with investments. \$200 to \$500. Dept. 116, Paul Kaye, 149 Broadway, N. Y.

START a cleaning, pressing, dyeing shop. Splendid field. Big profits. Booklet free. International System, Dept. 20, Excelsior Springs, Missouri.

PROSPEROUS Realty business of your own or position worth \$3,500? Our graduates have choice. Training at homes prepares you in short time. We help you make good. Bulletin free. Penn Realty School, 19th & Ellsworth, Philadelphia.

\$2,500 to \$5,000 yearly. Plasterers in demand. Interesting, big pay, easily, quickly learned. Instruction \$1 (bill). E. J. Rush, Gay Street, Phoenixville, Pa.

LET us start you manufacturing rustic flower stands and hanging baskets at home. You can sell all you make, \$5.00 worth of material will make \$25.00 worth of stands, or baskets. Samples \$2.00 each postpaid. Norton Toy Co., South Easton, Massachusetts.

STAMPS AND COINS

LIKE Triangular Stamps? To introduce our Sudden Service Approval we'll send triangular Plume, set China ships, large \$1.00 United States revenue, also packet 50 foreign, millimeter scale, perforation, gauge, ruler and bargain lists—for only 9c. Fennel Stamp Company, Department C, Fullerton Building, St. Louis, Missouri.

CALIFORNIA gold \$1 size, 27c; \$1 1/2 size, 53c. White cent and catalogue, 10c. Norman Shultz, Colorado Springs, Colorado.

HAVING no office I can offer these bargains. 1000 American hinges and 100 different stamps, 25c. 100 British Colonies, 35c. Get my free price list and try my "approval service." Elwood D. Weber, 812 South Avenue, Plainfield, New Jersey.

158 Genuine Foreign Stamps—Mexico War Issues, Venezuela, Salvador and India Service, Guatemala, China, etc., only 10c. Finest approval sheets 50% to 60%. Agents wanted. Big 72-p. Lists free. We buy stamps. Established 29 years. Hussman Stamp Company, Dept. 55, St. Louis, Missouri.

STAMPS—50 varieties, Africa, Brazil, Peru, Cuba, Mexico, etc., and Album 10c. 50 different U. S. 25c. 1,000 hinges, 10c. 1,000 mixed, 40c. List free. I buy stamps. C. Stegman, 5949 Cole Brilliante, St. Louis, Missouri.

50 different French Colonial stamps, 25c. Nickles, 122 Florida, Washington, D. C.

TEN varieties Nyassa, 1901, 21c; 2 Congo, 1909, 16c; 2 Hejaz, 1918, 7c; Philippines 2 peso, 1911, 8c; Sudan, 10 plastre, 1907, 20c. Gopher, 3515 Third Avenue South, Minneapolis.

WONDER packet stamps, 10c. Approvals. Buckey, 712-A Bowen, Dayton, Ohio.

17 VARIETIES Bulgaria stamps, 20 cents. List of 7,000 low-priced stamps free. Chambers Stamp Company, 1110 Nassau Street, New York City.

OLD coins, large Fall selling catalogue of coins for sale free. Catalogue quoting prices paid for coins, ten cents. William Hesslein, 101A Tremont Street, Boston, Massachusetts.

STAMPS, 20 unused. All different 3 cents. Mention paper. Quaker Stamp Co., Toledo, Ohio.

OLD money wanted. \$2 to \$500 each paid for hundreds of coins. Keep all old or odd money, it may be very valuable. Send 10 cents for New Illustrated Coin Value Book, 4x6. We pay cash. Clarke Coin Company, Ave. 6, LeRoy, New York.

1000 American hinges and premium set 10c. Finest approvals 50% to 75%. Albums and supplies cheap. Big list free. Send reference. Supreme Stamp Co., 5 Bradford, Pennsylvania.

RUSSIAN starvation set, showing starving women and children, picture of Hades, etc., should be in every collection. Best postpaid with 250 hinges and perforation gauge for 5c. Fenway net approvals with every order. Fenway Stamp Co., Fenway Station, Boston, Massachusetts.

FREE. 3 different Abyssinian stamps and sensational premium offers to approval applicants enclosing 2c. 1oor, 642 Eugene Street, Indianapolis, Indiana.

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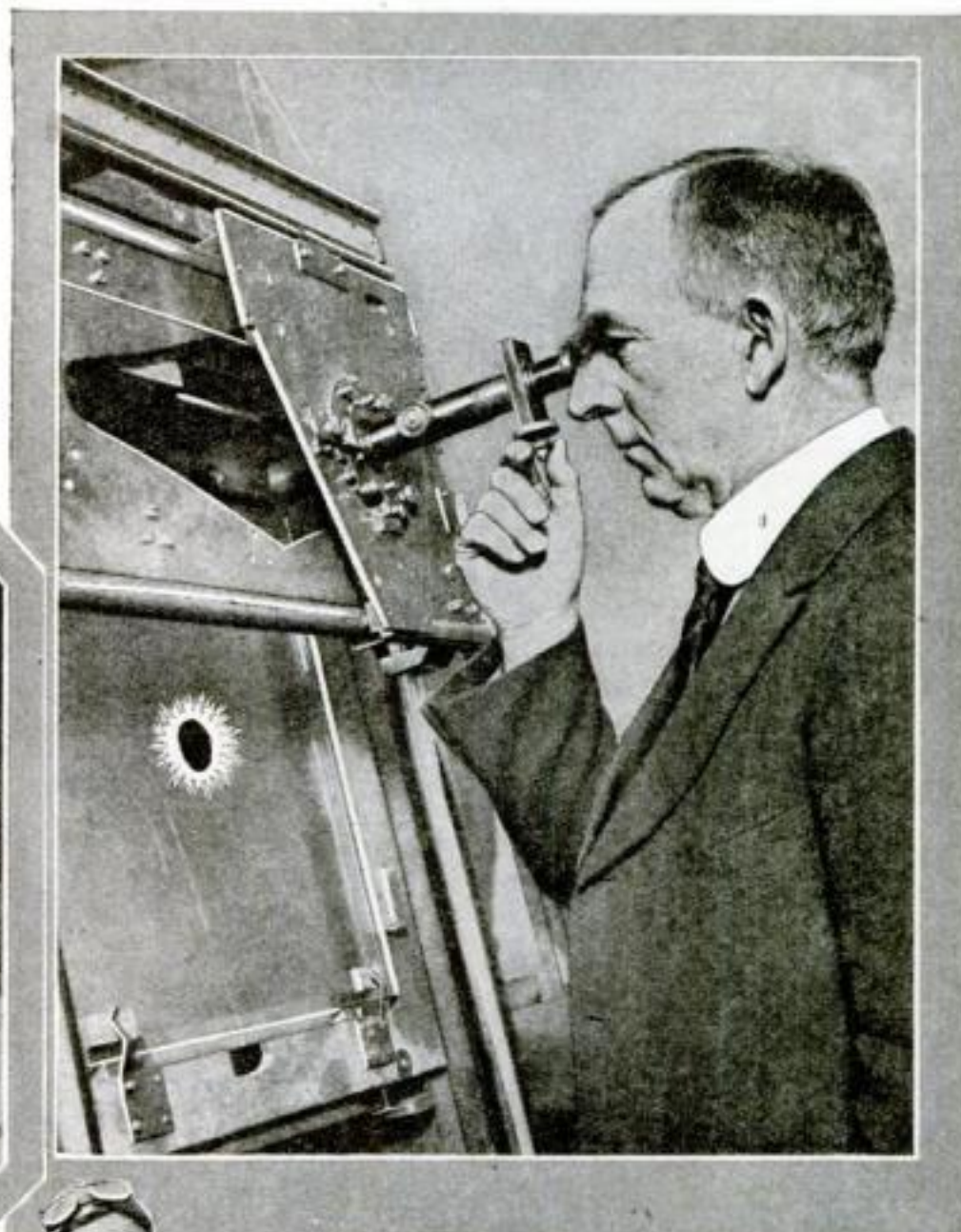
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Men of the Hour in Science and Discovery



Talking across the Atlantic

TALKING by radio from his office in New York City to distinguished scientists in London, England, Henry B. Thayer, president of the American Telephone & Telegraph Co., recently demonstrated a revolutionary invention in long distance radio.

This invention, known as "side band transmission," of interest to every radio fan, is described on page 43 by Jack Binns.

Thayer's transatlantic conversation was a test of radio apparatus made possible by cooperation between the American Telephone & Telegraph Co. and the Radio Corporation of America.

To Broadcast Movies

NOT content with his success in transmitting photographs by radio, C. Francis Jenkins, Washington, D. C., inventor (below), now proposes to broadcast movies by the same means. His project will be explained in our May issue.



© Keystone

Around the World in 60 Days!

BY FLYING around the world in 60 days, Alan Cobham, most famous of British civilian aviators, proposes now to go Jules Verne one better.

Accompanied by Lieut.-Commander Mackenzie Grieve, who was with Hawker in his attempted cross-Atlantic flight, and flying a De Havilland machine driven by a 240-horsepower Sidney-Puma engine, Cobham will girdle the globe by way of Central Europe, Constantinople, Bagdad, India, China, Japan, the Aleutian Islands, Vancouver, Newfoundland, and the Atlantic.

"If any airman can accomplish the feat," said a noted aviation authority recently, "Cobham can do it, because he will leave *nothing* to chance"—thereby explaining Cobham's success as an aviator.

Tests Einstein Theory

EXAMINING ten thousand photographic plates exposed during last summer's expedition to the Antipodes to observe the recent eclipse of the sun, Dr. W. W. Campbell, director of the Lick Observatory, Calif., and new president of the University of California, expects to prove or disprove conclusively the Einstein theory of relativity.

Science for Everybody

BY BROADCASTING reports of the recent epoch-making meetings of American scientists in Boston, Dr. Edward E. Slosson, of Washington, D. C., noted science writer and editor, has performed an inestimable service in popularizing science in America. One result of these meetings is discussed on page 32.





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How Our Earth Was Formed

Will It Perish in Collision with Some Huge Wandering Star— to Die in Flaming Dust as It Was Born?

*The Story of Man and His World***By Dr. E. E. Free***A Fascinating Serial of Evolution*

This is the second of a fascinating series of articles on the secrets of life, prepared with the cooperation of some of the world's leading scientists.

A TREMENDOUS burst of light blazed out in infinite space; two huge stars surged together at terrific speed. They shattered vast fragments from each other as they passed—and thus our earth was born!

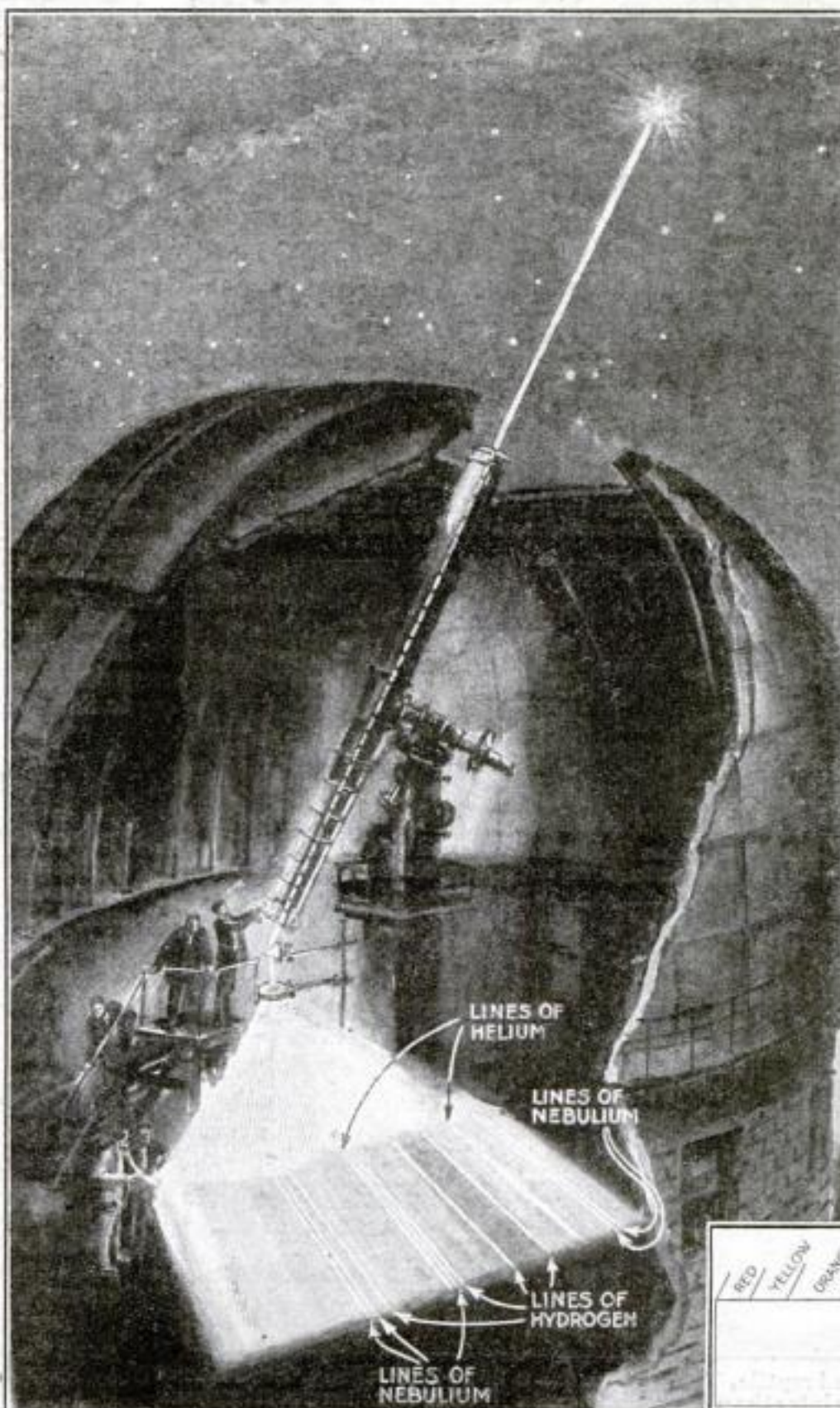
No romance is more interesting, no chapter of science more inspiring, than the story of how modern astronomers have learned to read the meaning of the stars; of how they have gone exploring into the vast depths of space and come back with answers to some of the first questions that man ever asked himself; questions of what the stars are made of, why they shine, how far away they are.

The First Science

Astronomy was the first science. Six thousand years ago, on the plains of Chaldea, shepherds who watched by night under the cloudless desert sky learned to notice the stars, to understand their motions; thereby to tell the time or the points of the compass or to predict the coming seasons.

A little later the priests became astronomers and from the tall towers of the Babylonian temples men watched each night to chart the movement of the planets, to make star maps and observe eclipses; to inquire, in all earnestness and honesty, whether they could learn to read of human destinies among the stars.

But though the stars had been studied for 60 centuries, we knew, even 50 years ago, almost nothing about what they really were. We knew that they were glowing bodies of some kind.

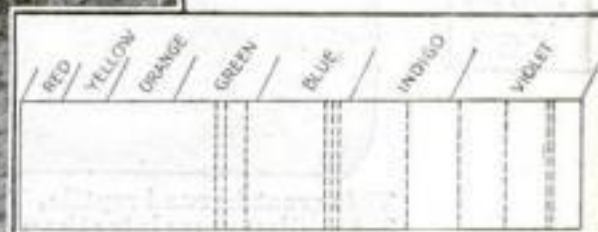


We suspected that they were a good deal like our own sun. We knew that they were very far off, but only for a scant dozen of the nearest ones did we have much idea of just how far.

Today we know enormously more than this. We know what chemical elements exist in the stars and that they are the same elements that we have on earth. We know the distances of more than 2000 of the stars. We know how hot they are; that some are thousands of degrees hotter than the sun, while others are cooler. We know that some stars are dwarfs even smaller than our sun, while others are giants larger in diameter than the entire orbit of our earth. Three of these giant stars have actually been weighed and measured.

Two Star Streams

We know that double stars exist; two great globes, each larger than our sun, revolving like the balls of a dumb-bell around their common center of gravity. We know that all the stars are moving, that there are two great streams of them flying through each other in opposite directions, like ships coming and going on the



How Astronomers Read the Secrets of the Stars

NEARLY all that we know of the stars—what they are made of, how fast they travel, and how far away they are—we have learned by means of the spectroscope, an instrument that splits up beams of white light from luminous bodies into a ribbon of the seven primary colors known as the spectrum, in the order

shown in the diagram above at right. The above illustration shows how the spectrum of a gaseous nebula might look if it could be spread out on the floor. Running across the spectrum are a number of lines at irregular intervals. By these lines scientists have learned to read what chemical elements are in the white hot clouds of

glowing gas that produce the light—in this instance hydrogen, helium, and nebium. Nebium is believed to be an element unknown on earth. Each element produces one or more lines.

The spectroscope also tells us whether a star is moving toward us or away from us, and how fast.

Actors from the Drama of Life that Began about 1600 Million Years Ago

sea. We even know something of the shape and size of the star cloud made up of these two streams, the cloud that includes all the stars we see and which is, for us, the visible universe.

Most of this tremendous increase in scientific knowledge has been due to an entirely new method of investigation, to an instrument called the spectroscope, which analyzes the light of the stars and tells us what particular kinds of glowing matter produced that light.

A Yardstick for the Heavens

Another use of the spectroscope is as a celestial yardstick. By its help we can measure how far away the stars are; whether a star is moving toward us or away from us, and how fast. Some of the star distances thus discovered are astonishing. Even the nearest star, one that is close enough to be measured by ordinary surveying methods without using the spectroscope at all, is 26 trillion miles from the earth. For the more distant stars—the ones measured recently by the newer methods—miles become altogether meaningless and astronomers use the light-year, which is the distance that light, moving at 186,000 miles a second, will travel in one year. The farthest stars yet measured are 220,000 of these light-years from us. The visible universe, the cloud of stars that we see and of which our sun is one, is believed to cover the astonishing distance of at least 300,000 light-years from side to side.

These figures simply demolish the human imagination. Think of the distance from us to the sun. For a man, that is a tremendous distance. An airplane flying night and day at 200 miles an hour would need a little over 52 years to make the trip. Yet this 52-year journey to the sun is only about one fourteen billionth of the distance to the farthest known star; about the same as the thickness of a sheet of paper in comparison with the distance from New York to San Francisco.

Two Billion Known Stars

And in this astonishing depth of space there are over two billion stars that we know about; one star for every man, woman and child now alive in the world, and enough stars left over so that everybody in the United States could have three or four extra. Probably there are a vastly larger number of stars that we do not know about because they are too small or because they are dark and send no light to us. Billions on billions of stars, most of them larger than our sun; no one knows how many billions more of planets and earths and moons, of star clusters and of nebulae, all of them inside a space so vast that the nearest of them are trillions of miles apart—this is what we know of the universe.

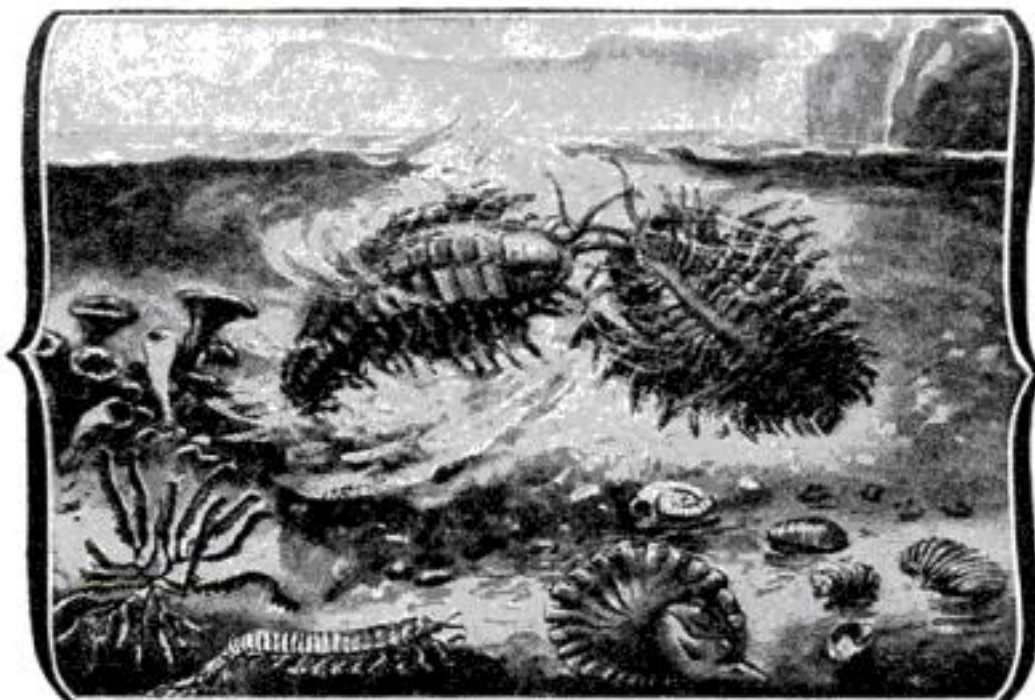
And man, crawling around on his one small dust mote of an earth, has been able to stretch out the fingers of his mind through all this swarm of other worlds; has been able to weigh and measure and to understand.

No fact in the universe, no achievement of man, is more truly wonderful than this.

Now let us look back into time instead of out into space. How did this earth of ours, so tiny but so all-important to life, come to be formed?

The earth was once, we believe, a part of the sun. It was pulled out of the sun,

IN THE
AGE OF
TRILOBITES
600
MILLION
YEARS
AGO



A battle between trilobites, ancestors of our modern sow bugs, which dominated the seas about 600 million years ago. Notice that it took life about a billion years to develop itself into this crude buglike animal

IN THE
AGE OF
FISHES
375
MILLION
YEARS
AGO



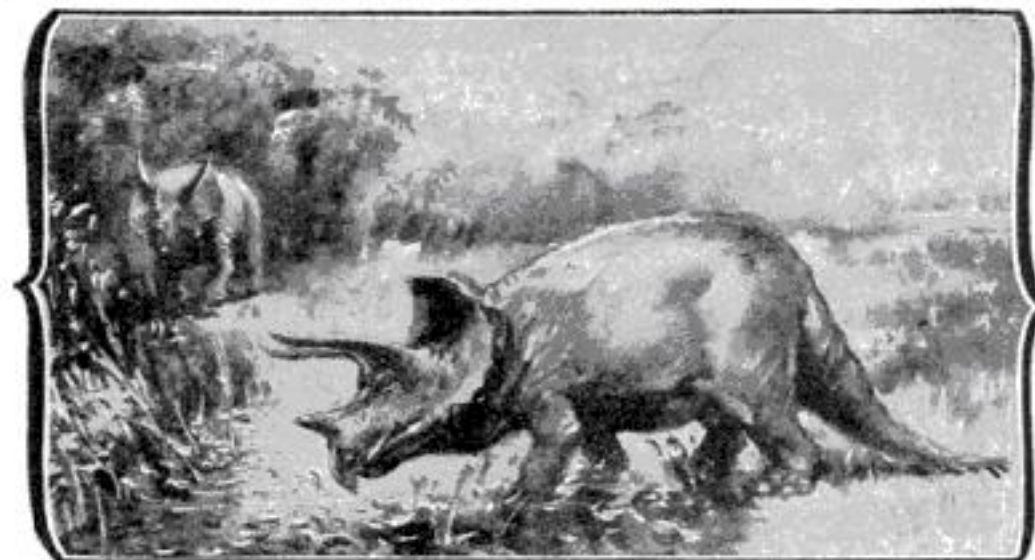
A gigantic toothed fish, the dominant form of life about 225 million years later than the age of trilobites, as evidenced in the rock strata of Ohio

IN THE
AGE OF
COAL
300
MILLION
YEARS
AGO



After about 75 million more years life had developed to the stage of these amphibians—lizard-like creatures that could live either in air or in water

IN THE
AGE OF
REPTILES
75
MILLION
YEARS
AGO



This great horned reptile, Triceratops, from 20 to 25 feet long, lived about 225 million years later than the amphibians. Notice the sharp cutting beak

IN THE
AGE OF
MAMMALS
40
MILLION
YEARS
AGO



Large hoofed Uintatherium now extinct, and a small form of camel, typical of the ancient mammals that lived about 35 million years later than the great horned reptile, or about 40 million years before the advent of man



Here is the great spiral nebula in Andromeda, a tremendous mass of whirling gases thousands of times larger than our whole solar system. This is perhaps one stage in the formation of a star

billions of years ago, by an encounter with a passing star.

The sun is a star; one of the two billion odd stars that we know. It is not fixed at a certain point in space. On the contrary, it is moving about 13 miles every second, carrying us and all the planets with it. The other stars move too. All of them drift about in space like flying gnats in a great room.

When Drifting Suns Came Together

The sun has been drifting about in that way for a very long time. It was once larger than now, and hotter. It had no family of planets as it has today. It was merely an unencumbered single star drifting about aimlessly by itself.

And then, one day, eight or ten billion years ago, another one of these drifting stars happened to come too close to our sun. Perhaps it came within a few billion miles; close enough, anyway, that the attraction of gravity between it and the sun grew to be dangerously large. This attraction pulled out of the half-fluid sun a lot of drops of matter, much as the gravity of the earth will pull drops of water out of a wetted sponge if you hold it up.

The other star moved on. It left behind a somewhat damaged sun; a sun surrounded by a great revolving cloud of lumps of matter that had been pulled out of it. Gradually these lumps gathered into larger lumps. These are the planets. The earth is one of them.

This is the modern idea of how the earth was formed. Our globe grew, you perceive, gradually; lump by lump, as the bits of matter that had been pulled out from the sun were picked up. Already six billion or eight billion years ago the earth had grown to about its present shape and size.

It is reasonably certain that the earth at first was very hot, hot enough to be

molten all the way through. Its surface was a sea of melted rock in which great flaming tides hundreds of feet high raced twice daily around the globe. Gradually the rock grew cooler. It hardened. After awhile there was a solid surface crust. And slowly, after many millions of years, this crust grew cool enough for water to collect in hollows on it and to stay there. The first oceans were formed.

Then ended the astronomical part of earth history; then the geological part began. With the first seas and what went on in them we come to the part of the story of the world that we can read in the record of the rocks.

The rocks under our feet, the rocks that make up the accessible crust of the earth, are in separate layers, piled one on top of each other like a pile of blankets in a store. Geologists call these layers strata.

Earthquakes and volcanic eruptions, other convulsions of the earth, have twisted and torn these strata. Layers that were once deep down in the earth have been tilted up so that they are exposed on the surface where geologists can

get at them for study. And so, gradually, we have learned a good deal about what they are, about which layers are on top and which underneath, all over the earth.

We have learned, too, how these rock layers were made. There is no doubt that they were formed in water; that most of them were produced in about the same way that rocks are still being formed on the bottom of the ocean close to the shore—by the slow hardening of loose sands and clays carried down by rivers into the sea.

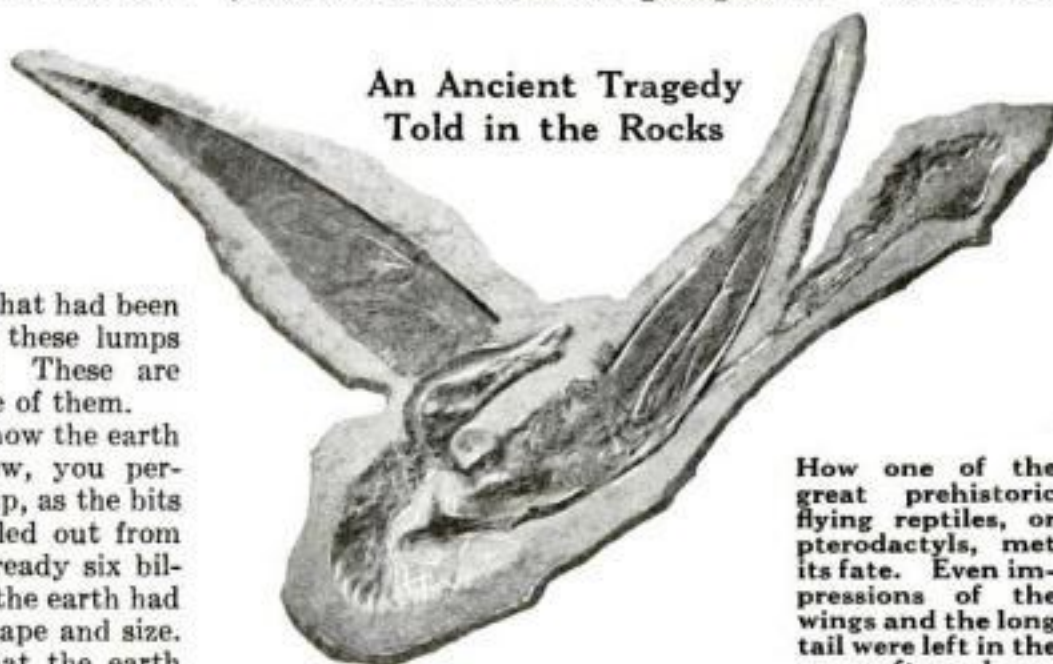
How Earth Strata Were Formed

Very few rivers are entirely clear. There is always a little sediment, as you can prove for yourself by allowing a little of the water of the Mississippi, for example, to stand a day or so in a glass. This sediment goes out to sea with the water. More sediment, the sandier part of it, washes out along the bottom of the river. All of it, when it gets to the sea, falls to the bottom. There it gradually hardens. It is slowly changed into rock, into sandstone or slate or, with the addition of chemically formed lime, into limestone.

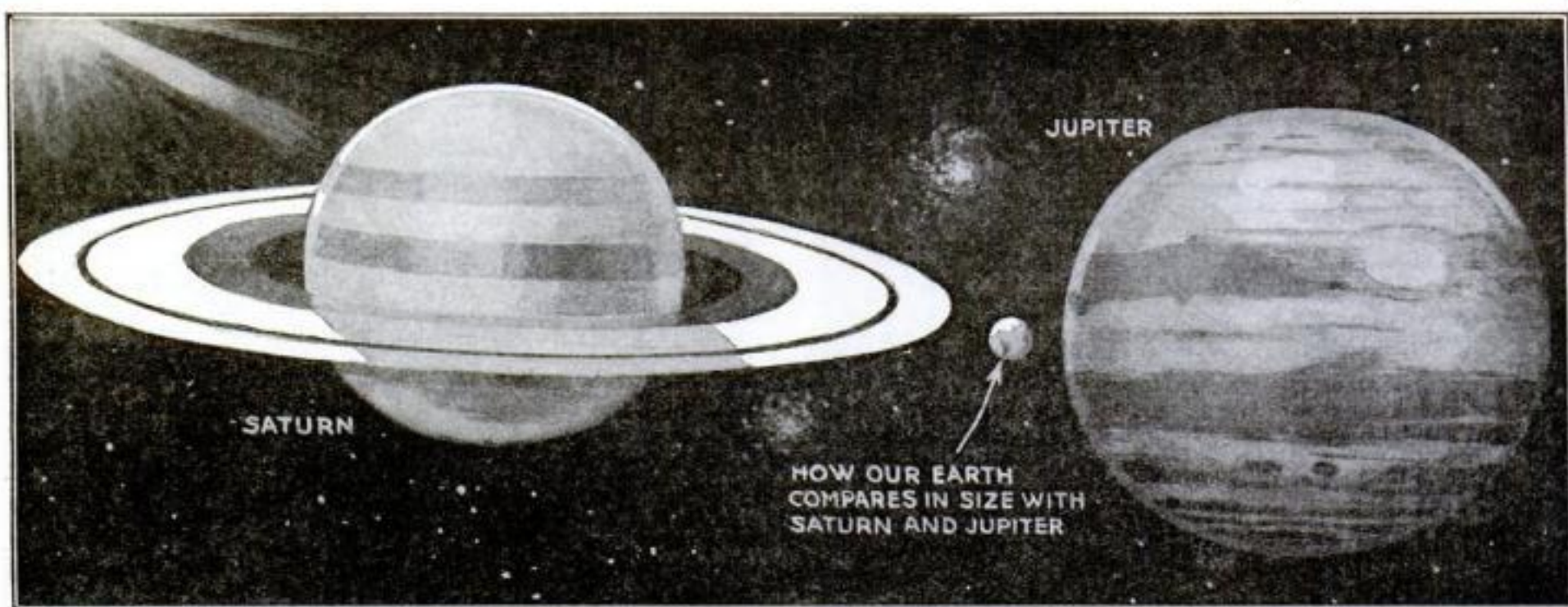
Now and then a fish dies and its bones sink to the bottom. Occasionally a shellfish or a tree trunk or the bones of some land animal, wash out and are buried by the mud. These make the fossils. Millions of years later the fossils and the sediment together, raised above the sea by some movement of the earth's crust, will make a rock layer for future geologists to study.

Thus were formed the strata of the earth. Sometimes rock was formed near the shore, so that we can see in it the footprints of some great reptile that ventured

An Ancient Tragedy Told in the Rocks



How one of the great prehistoric flying reptiles, or pterodactyls, met its fate. Even impressions of the wings and the long tail were left in the soft mud



So staggering are the sizes in our solar system that even the planet Jupiter, beside which our earth is a pygmy, is less than one thousandth the size of the sun

out one day, millions of years ago, onto a muddy beach while the tide was low. Sometimes we find layers of coal where the rank vegetation of some seashore marsh gathered for ages and was buried. Altogether there are at least 55 miles of strata, for that is about the total thickness of the rock layers that geologists have identified and mapped.

How much time does this involve? How long did it take for these 55 miles of rock to accumulate, sand grain on sand grain, in the sea?

Until very recently geologists were not sure. The rate at which the sediment accumulates is irregular. It depends on the speed of the rivers from year to year and age to age. The age of rocks in years cannot be determined merely from how deep they lie in the pile of strata. The problem seemed to be insoluble until the discovery of radium gave us the key to the puzzle.

The extraordinary thing about radium is that its atoms are explosive. A certain percentage of them explodes every minute. They leave behind them certain other elements, especially lead. Accordingly, if you find some radium in a rock, or, better

still, if you find some of another element—uranium—the atoms of which explode more slowly, and if you also find some lead, you can conclude that the lead has been formed from the radium or from the uranium. Determine the exact amounts of uranium and of lead and you can calculate how long this has been going on—that is, how long it has been since that rock was formed.

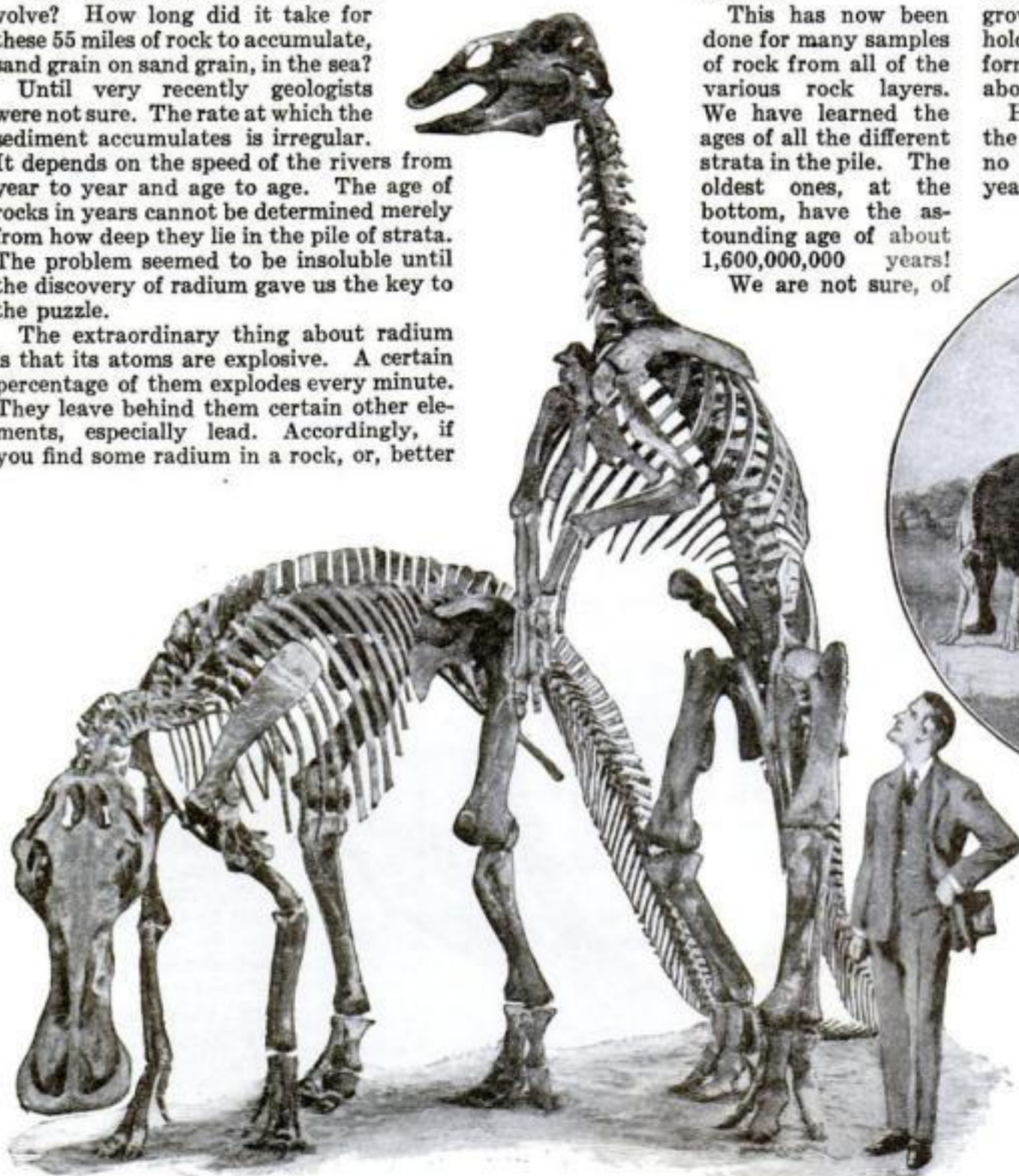
This has now been done for many samples of rock from all of the various rock layers. We have learned the ages of all the different strata in the pile. The oldest ones, at the bottom, have the astounding age of about 1,600,000,000 years!

We are not sure, of

course, that they are *exactly* 1,600,000,000 years old. The radium clock is not quite so accurate as that. But we are sure that it was a very long time; a time to be measured, at the very least, in hundreds of millions of years.

And even this immense age is only the age of the oldest rocks. The earth itself is far older. Before rocks could be formed at all, the primeval earth had to finish its growth, had to become cool enough to hold a liquid sea, had to shrink enough to form ocean basins and thus to raise land above the waters.

How many billions of years it took for the earth to get this far in its development, no one knows. It is almost two billion years since the formation of the first rocks;



Two reconstructed skeletons of gigantic plant-eating dinosaurs of the Age of Reptiles, as they now stand in the American Museum of Natural History, New York. The smaller picture shows them as it is believed they appeared in life

it is perhaps six billion more since the birth of the world. Who knows how many more billions for the previous history of the sun?

This is our astonishing vista of the past. Quite as incomprehensible, it is, as the quintillion miles of known space. In comparison with even two billion years, the whole history of America since Columbus is no longer than eight minutes out of a human lifetime!

So much for our vista backward. Can we look forward too? Can science return at last to the ancient effort of the first astrologers and learn to read the

(Continued on page 120)

Inventor Promises Disk Record Movie Shows for the Home

Film Projector Runs like a Talking Machine

WHAT Edison did with the talking machine; what Bell did with the telephone; what Ford did with the automobile, C. Francis Jenkins, inventor, of Washington, D. C., now proposes to do with the movies.

By means of an ingenious prism projector apparatus, growing out of his study of prisms—a study by which, incidentally, Jenkins worked out the principle of radio transmission of photographs, to be described in the next issue of *POPULAR SCIENCE MONTHLY*—the Washington inventor has perfected a "movie record" machine that, he declares, will put movies in the home, along with the talking machine, the telephone, and radio, and at a cost within the average man's pocket-book.

For some time leaders in the motion picture industry have believed that the greatest future use of movies would be in the home. But to meet the requirements of this field, it was necessary to devise a projecting machine as easily managed as a talking machine, with "records" just as simple in form. This, Jenkins believes he has done. With his disk record apparatus he hopes to make available to stay-at-homes the greatest motion picture productions.

In construction, the new home movie machine is surprisingly simple. To operate the phonograph-like disk containing the movie film, a mechanism like that of the modern cabinet phonograph is used. The miniature movie is projected on the inside of the hinged cabinet cover.

One of the first problems encountered was that of devising a small, compact disk that would hold the thousands of pictures necessary for one reel of movies. This, Jenkins accomplished in a truly ingenious way. First, the opening pictures of a reel were pasted in order around the rim of a paper disk about the size of a large disk

Note how the paper disks that have been run off are bent up over a guide frame to expose the succeeding pictures to the projection prisms



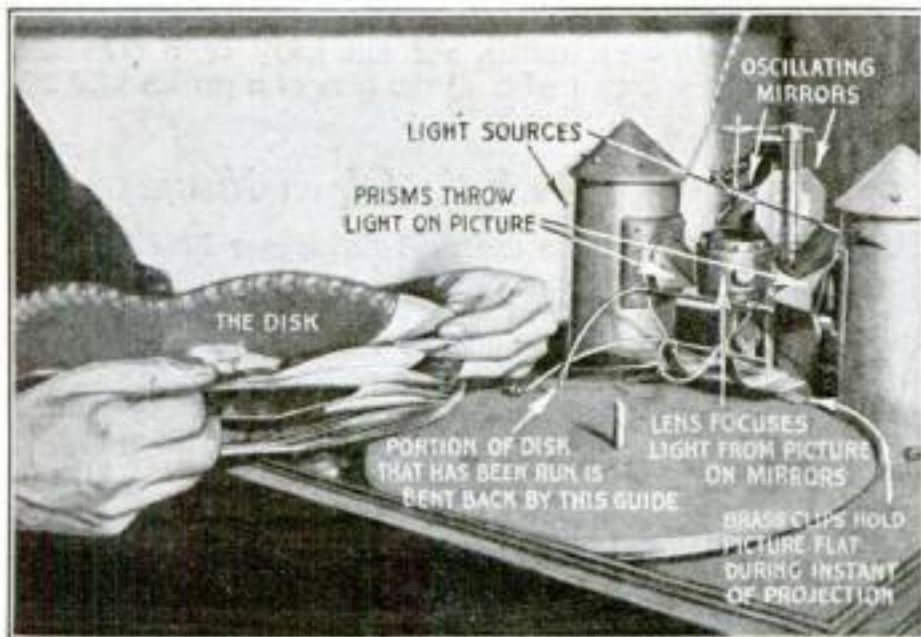
How the inventor, C. Francis Jenkins, has converted a talking machine into a disk record movie projector. By an ingenious arrangement of prisms and oscillating mirror, pictures attached in sequence to paper disks, as shown at left, are projected as movies on the cabinet

record. Naturally, one disk accommodated comparatively few pictures. So Jenkins arranged the succeeding pictures of the reel on other similar disks, which he placed in order beneath the first one.

By means of a radial slit, each disk in the series slightly overlapped the one beneath it, so that when the pile of disks was rotated, with a guide wheel running between the layers of paper, the effect was to produce a continuous spiral strip of paper and pictures. This arrangement, somewhat like a spiral spring, thus produced a continuous sequence of pictures. As the disks were run off, the thumblike frame of the guide wheel bent back the used disks so as to expose the succeeding pictures.

Then the problem was to provide a means of projection, including an intermittent mechanism to produce for the unaided eye the effect of one continuous moving picture on the screen. This, Jenkins was able to solve through his knowledge of prisms. On each side of the image he desired to project, Jenkins placed a prism that caught the light and threw it on the picture. From the picture the light passed upward through a lens to two oscillating mirrors, which in turn projected it on the screen.

A user of the disk movie machine simply turns on the electric current that drives the small motor, places on the rotatable table his disk "record" that contains the "reel" of the film, switches on the projector light, then sits back to enjoy the show. The thumblike guide wheel arrangement follows down the spiral formed by the overlapping disks; the oscillating mirrors pick up the images thrown upward by the prism arrangement, and the moving pictures are projected in miniature.



Complete apparatus for producing disk movies. Note that the paper disks are held apart to show how each disk overlaps the one below it, giving the effect of a continuous circular strip

Why America Uses More Dope than China

WHAT are the facts about habit-forming drugs and the fascination they hold for their short-lived addicts?

Just now Americans are facing the astounding fact that in this country last year there was a consumption of 36 grains per capita of habit-forming drugs; that we used 40 times as much of these soul-wrecking chemicals as China, and that consumption is growing, rather than decreasing, at an alarming rate.

Where do these drugs come from? How are they prepared? Why will people steal and slay to get them? What are the physiological and moral effects of these drugs?

These are some of the questions that will be answered in the May issue of *POPULAR SCIENCE MONTHLY*. The drug problem is the most vital America has faced since prohibition.

Can We See with Our Noses

Amazing Feats of 17-Year-Old Blind and Deaf Girl, Who Smells Colors and Feels Sound, Convince Scientists that Unused Powers Lie Asleep in Our Senses

CAN we learn to see with our noses? Can we learn to hear with our finger tips? Can we develop eyes in the backs of our heads or wherever else we happen to need them?

The amazing case of Willetta Huggins, the 17-year-old blind and deaf girl of Janesville, Wis., makes these questions much less fantastic than they would have seemed a year ago. For Willetta can do some of these things.

While we human beings have been developing to a high degree our senses of sight and hearing, have we failed to develop at the same rate our senses of smell and touch? The accomplishments of this little girl, handicapped from babyhood, seem to prove that this is so.

She Smells Color!

Willetta can recognize colors by their smell. She can hear spoken words by placing the sensitive tips of her fingers against the throat of the speaker. She can identify different people by their personal odors. *She knows, even, when the family cat enters the room for a moment and then leaves.*

Physicians and psychologists are still debating the exact nature and extent of Willetta's powers. Scientific tests of her case are still in progress. There seems little doubt, however, from the experiments made that she really does possess a remarkable development of the senses of smell and of touch.

When she was nine years old, Willetta was left an orphan. A year later she was admitted to the Wisconsin School for the Blind at Janesville. She was then partly blind and nearly deaf. Within five years she had lost what remained of her hearing and a year later she became totally blind.

Under this double misfortune she grew, as was natural, somewhat morose and listless. For a time she showed little interest in anything. Suddenly this changed. She was introduced by her teachers to Helen Keller's method of "hearing" by feeling the lips.

Her Interest Is Awakened

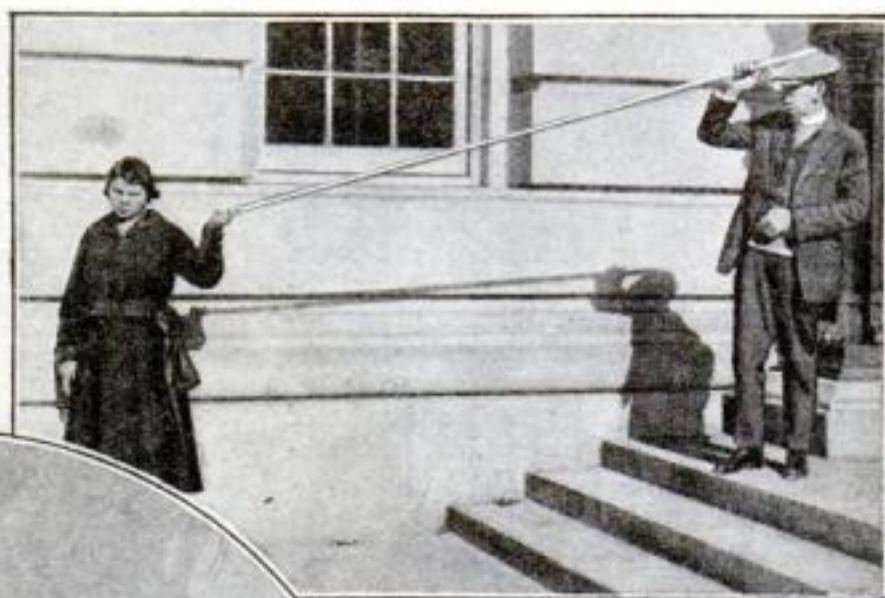
Almost overnight Willetta lost her listlessness and indifference. She not only found out that she could use the method made famous by Miss Keller, but she discovered a better method. She found that when she placed the tips of her fingers on the throat of a person who was speaking, she could "feel" what was said merely by the vibrations of the throat. It was not necessary for her to touch the lips at all.

This unusual ability and the rapidity

with which she learned the use of it, attracted the attention of her teachers and of the medical men attached to the institution. It was found that her sense of smell was no less extraordinary. The fame of her accomplishments spread. Attention



To demonstrate that persons with normal sight and hearing can develop the sense of touch so as to distinguish sounds with their hands, two students



Through her sensitive finger tips, this remarkable 17-year-old deaf-blind girl feels words as they vibrate down a long pole resting on the head of the speaker



Willetta Huggins, deaf and blind, hears the world of voices by placing her fingers on the receiver diaphragm of a telephone instrument. It is possible, scientists believe, that Willetta differs from the rest of us only in that she has learned how to use senses that we have neglected

was attracted in Chicago and on April 26, 1922, Willetta was examined before the Chicago Medical Society.

There is still some controversy about exactly what she can do, but the following facts are well attested:

She can recognize spoken sounds when her fingers are touching the throat of the speaker. She insists that she does not hear the sounds. She says that she "feels" them. She can also feel sounds in the same way through a wooden rod, such as a billiard cue, one end of which is pressed against the chest of the speaker, the other end of which she touches.

She carries around with her a portable telephone of the kind used by deaf people, but she does not put it to her ear. Instead, she touches the vibrating diaphragm in the telephone with the tips of her fingers. She asserts that she feels the vibrations of sound in this way. She has been able, under test, to hear concerts and stage performances and to describe correctly what was happening. Aided by her telephonic apparatus, she can carry on a conversation with all the ease of a person who has perfect hearing.

Feels the Ink on Newspapers

She can read newspaper headlines, the denominations of paper money, and similar matter printed in large type merely by running her fingers over it. She says she feels the ink on the paper.

There is little doubt, also, that she can really smell colors. In a series of careful tests arranged by Dr. Thomas J. Williams, of Chicago, and Professor Robert H. Gault, of the Department of Psychology of

at Northwestern University conducted this speaking tube test under the direction of Professor Gault, noted psychologist. With eyes and ears bandaged, and

And Hear with Our Fingers?

Northwestern University, Willetta's eyes were thoroughly blindfolded by a pair of black goggles stuffed and covered with cotton and fastened down to her forehead by adhesive tape. She named correctly the colors of 30 samples of yarn as well as many other colored objects. This was done even without touching the yarns, merely by smelling them when they were held close to the end of a glass tube about four inches long.

What Skeptics Say

The doctors who disbelieve in the reality of Willetta's powers explain these accomplishments as due to unconscious deception on her part. The girl's eyes and ears do not show any perceptible injury. If she is really blind and deaf, it is because of some trouble in her brain or in the nerves leading to it, not in the eye or ear themselves. The skeptics point to this fact. They say that she is not really deaf nor blind at all; that she merely thinks she is and thinks it so intensely that for all practical purposes she really cannot see or hear.

This would be quite possible. Such cases are common enough in the records of psychology. They are instances of extreme autosuggestion; harmful autosuggestion instead of the curative variety.

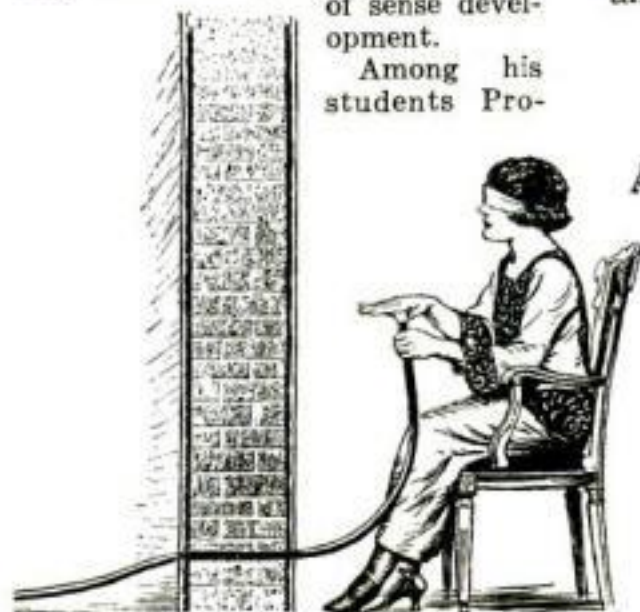
But that this is the case with Willetta seems doubtful. Whatever may be the real explanation of her marvelous powers, any kind of shamming, even unconscious shamming, seems to have been out of the question in the tests when Willetta was blindfolded. Even if her eyes had been normal, she could not have seen the colored yarns.

Then there are some additional experiments of Professor Gault on normal people, people with unimpaired equipment of eyes and ears. These experiments are even more significant than Willetta's case in supporting the idea that all of us may have unsuspected possibilities of sense development.

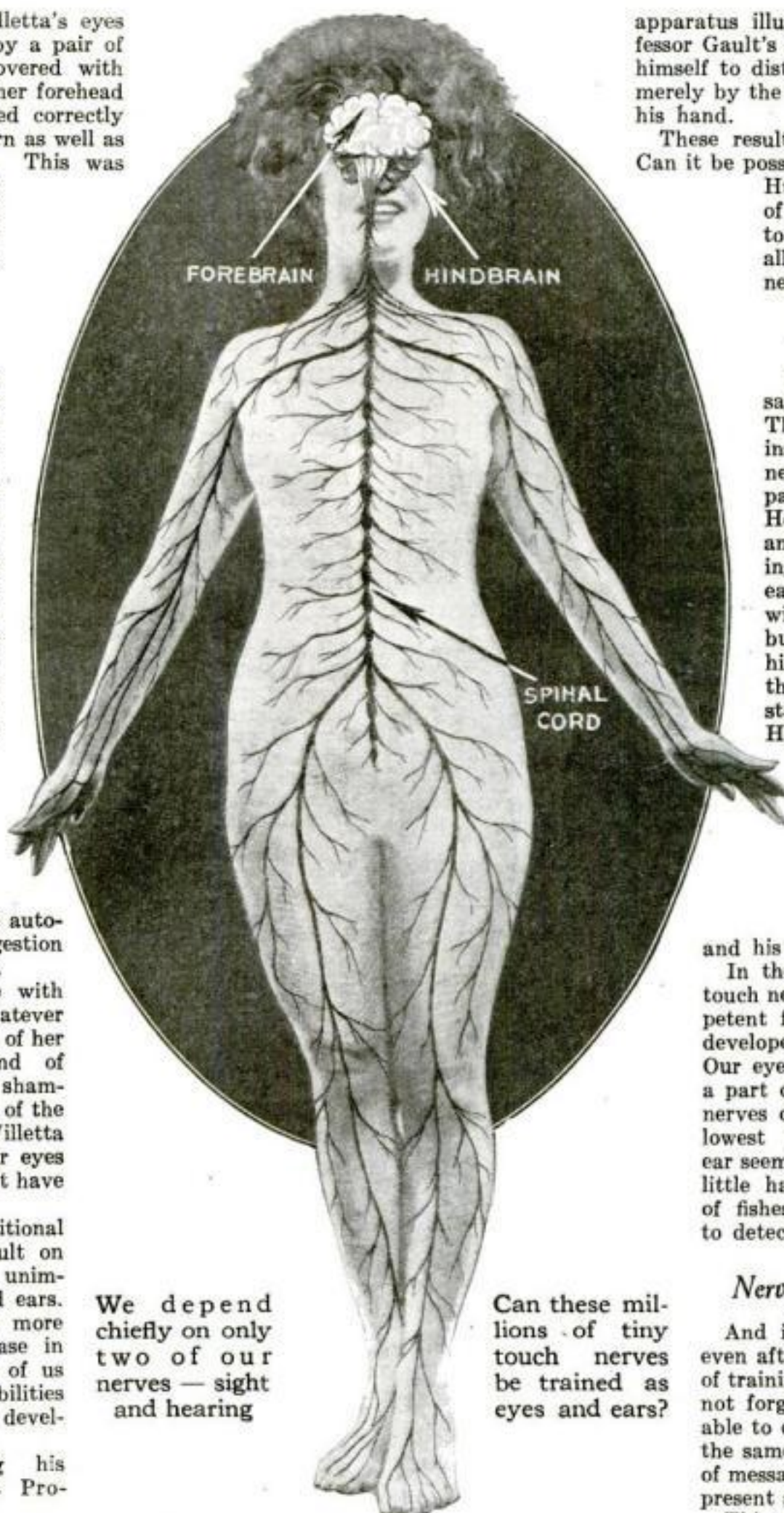
Among his students Pro-

We depend chiefly on only two of our nerves — sight and hearing

Can these millions of tiny touch nerves be trained as eyes and ears?



with one hand over the tube, the student at the right distinguished words spoken into the tube by a second student covered by a heavy blanket 30 feet away



A Million Unused Eyes and Ears

Professor Gault has discovered two persons who have the beginnings of Willetta's ability to smell colors. They can distinguish by smell alone whether two samples of colored yarn are alike or different. They are not able, as yet, to name each of the colors as Willetta does, but it is reasonable to believe that they possess the same power, the only difference being that they have not been forced to develop these powers of their other senses.

Professor Gault is testing, also, the possibility that normal persons can learn to feel sound in the same way as Willetta does. By means of the speaking-tube

apparatus illustrated below, one of Professor Gault's students has already taught himself to distinguish five different words merely by the feel of them on the palm of his hand.

These results are sufficiently startling. Can it be possible, one asks, that Willetta Huggins differs from the rest of us only in that she happens to know how to use senses that all of us possess but have neglected?

How Earthworms See

The biologist is inclined to say that it is quite possible. The common earthworm, for instance, has only one kind of nerves. His only sense, apparently, is the sense of touch. He has no eyes nor ears nor any sort of organ corresponding to our nose. Yet the earthworm can see, and will withdraw quickly into his burrow if you turn a light on him. He can hear perfectly the noise you make when you stamp your foot on the ground. He can smell his favorite foods some little distance away and he never makes a mistake about them.

Evidently the touch nerves in his body perform for him the functions of all the kinds of nerves; they are his eyes, his ears,

and his nose.

In the course of evolution, these touch nerves of the earthworm, competent for any kind of duty, have developed into our special senses. Our eye, for instance, originated as a part of a sensitive plate of touch nerves on the heads of some of the lowest backboned animals. Our ear seems to have grown out of some little hairlike organs on the heads of fishes; organs used, apparently, to detect vibrations in the water.

Nerve Powers Long Unused

And it may be that our nerves, even after all these millions of years of training for some special job, have not forgotten that they used to be able to do all the jobs; that one and the same nerve was once the carrier of messages relative to all five of our present senses.

This seems to be the biological lesson of the case of Willetta Huggins. It seems to follow, even more clearly, from the experiments of Professor Gault. And further evidence comes from Professor Louis Farigoule in France, who reported some months ago that he had been able to train certain men among a group of blinded soldiers so that they could perceive light by their finger tips.

It is possible that we stand on the threshold of amazing and revolutionary discoveries concerning our senses. We may be able not only to better the lot of those unfortunates who are blind or deaf, but to rediscover in ourselves capacities of smell and touch, perhaps of other senses which we do not dream we possess.

Noted Scientists Grapple with Food and Fuel Famine

Search for Secret Process by which Plants Harness Enormous Energy of Sunlight

By Thomas Elway

THE coal and oil supply of the world is rapidly being used up. What shall we do when it is gone?

Practical men have been asking themselves that question for a decade, and now the scientists of America have decided to answer it. They realize that a solution must be found, or civilization will perish.

At a recent meeting in Boston, the American Association for the Advancement of Science authorized its general secretary, Dr. D. T. MacDougal, to organize a cooperative scientific committee for the investigation and, if possible, the duplication of the process called "photosynthesis." This is the process by which green plants make sugar out of sunlight and water and the gases of the air.

Plants Supply Our Food and Fuel

This is the only source of food and fuel in the world. Our food is either itself of vegetable origin or is derived from animals that have fed on plants.

Fuel, of course, is a product of plant life, too. Coal, for instance, is merely the remains of plants that lived millions of years ago, using sunlight to make food and to grow, just as modern plants do. Oil likewise is the product of buried organic matter.

There are, it is true, a few other sources of energy. Most of these also depend on the sun, though some of them do so indirectly. An instance is water power. The heat of the sun evaporates water from the ocean. This water goes into the clouds and later falls as rain. It gathers into streams and lakes and rivers and finds its way back to the sea. It turns our water wheels and turbines as it goes.

Windmills and wave motors are other instances of using solar energy indirectly. Back of them all is the sun, the original energy that lifts the water out of the ocean, that keeps the winds moving, that starts the waves.

Coal and Oil Supply Is Limited

But these indirect sources of energy are not really of much importance at present. Nearly all the energy we use in the world—all our heat and power and artificial light—we get from coal or oil. And these, we must remember, represent our capital, not our income. They were accumulated during millions of years. When we have spent all of them, there will be no more.

The exhaustion of gasoline already is in sight. When it is gone, shall we have to stop using automobiles or can we find other fuel?

Scientists believe, of course, that we can find some other fuel, and there is much talk of alcohol. But alcohol can be made only from vegetable matter. To use starch or sugar for this purpose would decrease the world's food supply. Then there is the difficulty, to which we shall refer later, of the distillation of alcohol.

It is conceivable that ways will be found to tap totally new supplies of energy not



How We Use Sun Power



Oil



Coal



Water Power

From an inventory prepared for the American Association for the Advancement of Science by Dr. Edwin E. Slosson, famous scientist

Oil and coal are the stored-up energy of the sun, accumulated millions of years ago by plants that used sunlight for food and growth just as modern plants do

The power of Niagara also comes from the sun; for it is solar heat that lifts out of the ocean the water that makes the rain and forms rivers

New Ways to Use Sun Power



Sun Reflector



Wind Motor



Tide Arrester



Wave Motor

Can Solar Energy be used directly? Giant concave mirrors may be employed to concentrate the sun's heat on special types of water boilers

Wind motors, to harness the winds created by the sun's heat, offer another possibility. Improvement of the old fashioned windmill is interesting modern engineers

A system of locks creating seashore ponds to store the water power of the tides is still another frequent suggestion

Even wave motors are really sun motors to harness the power of the waves; for it is the sun's heat that makes the winds and keeps the waves moving



For 13 years Dr. Herman A. Spoehr, distinguished chemist of the Carnegie Institution, has been trying to discover the process by which green plants make sugar out of sunlight, water, and the gases of the air

related to the sun. There is, for instance, the energy of the atom. Radium gives out about as much energy as 350,000 times its weight of coal. The only trouble is that we have no way of getting at this atomic energy or controlling it. No one knows whether we ever will have. The same is true of other non-solar sources, such as the internal heat of the earth or the energy of its rotation or the attraction of the moon.

Energy Income from the Sun

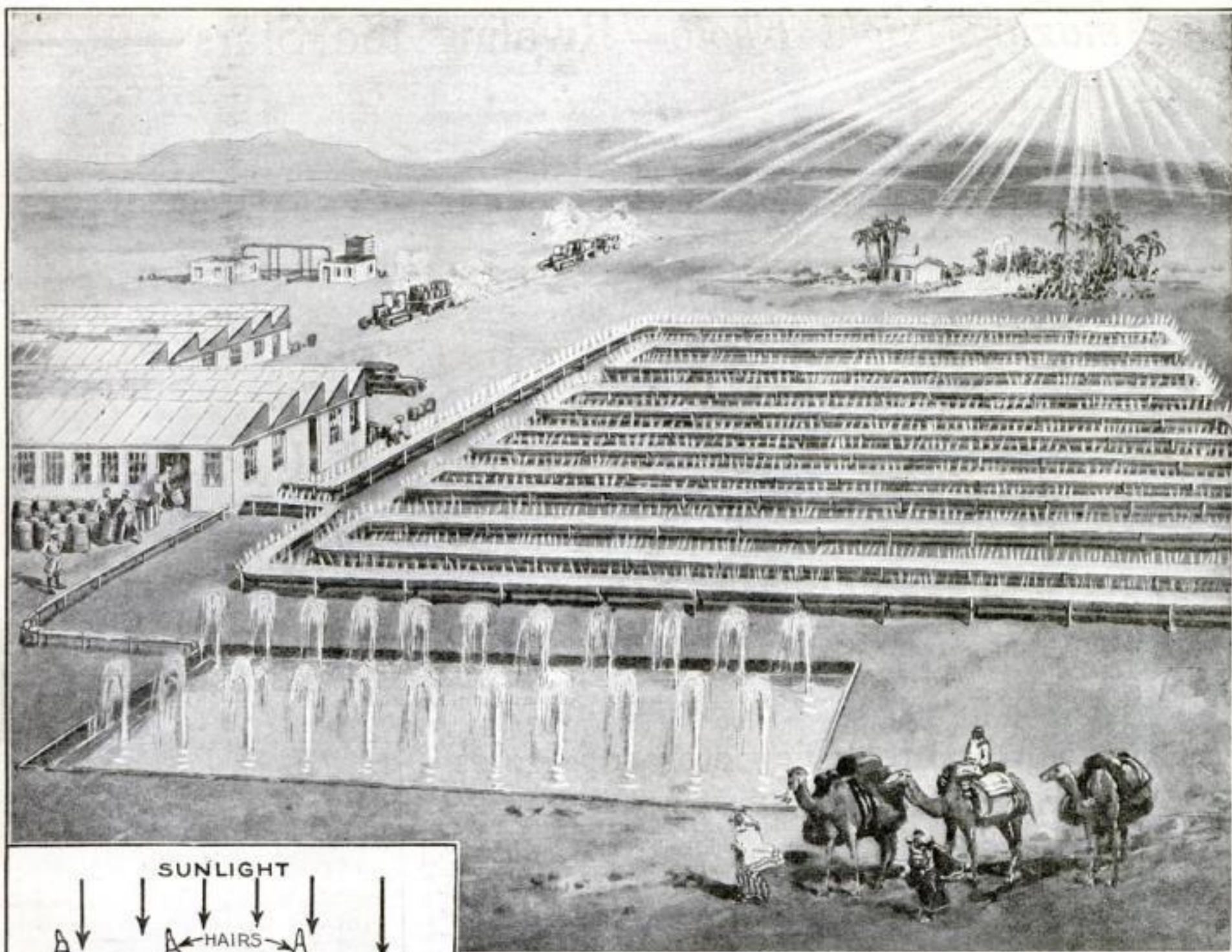
As practical business men facing a prospective shortage of our energy capital, would it not be prudent for us to stop counting on the uncertain prospect of atomic energy and find out whether we can make better use of the energy income that we now receive? This is the task set for Doctor MacDougal's committee of scientists.

Few people realize how tremendous this sun energy income is. Even after making deductions for the heat absorbed by the air and for cloudy weather and the like, the energy received from the sun each day equals well over 20 tons of coal an acre of the earth's surface. For the whole United States this amounts to an income of some 40 billion tons of coal a day, nearly 50 times as much energy as we use in a whole year!

The only way in which we now make use of this great energy income of ours is by means of the work of plants—by photosynthesis. Inside of each green leaf are a lot of little granules containing a green substance called chlorophyll. This substance absorbs sunlight. It also takes up carbon dioxide gas, the same gas that is in soda water, traces of which are always present in the air. From carbon dioxide and water, plus sunlight, the green chlorophyll makes sugar. The sugar feeds the plant. Ultimately it feeds the animals and us.

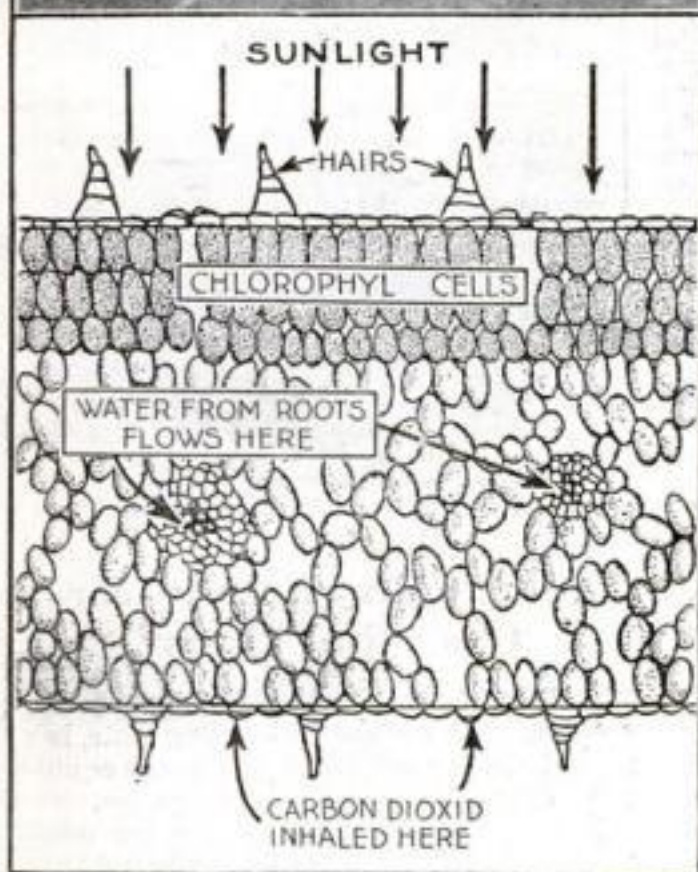
Searching for Plant Secrets

Unfortunately, the exact way in which chlorophyll puts water and carbon dioxide together to make sugar is unknown. At the meeting of the scientists in Boston, Dr. Herman A. Spoehr, of the Carnegie Institution, described researches that have



Sugar from Sunlight—A Future Desert Food Factory

A HUGE desert factory for the artificial production of sugar, as it may appear in the future if American scientists succeed in their efforts to discover the secret of how the green leaves of plants use sunlight to make sugar. Experimenters picture great glass pipes laid in mirror-lined troughs, where water charged with carbon dioxide can be exposed to the blazing desert sunlight; also spray boxes for the absorption of the carbon dioxide from the air. Wells in near-by oases will supply the necessary water. Adjoining factories will work up the results of solar action into edible sugar and other food products.



This cross section of a green leaf, highly magnified, shows how a living plant absorbs sunlight, water from its roots and carbon dioxide from the air to make sugar. The process is one that may be duplicated for the proposed desert food factories.

kept him busy for 13 years in an effort to find out just how photosynthesis works. Carbon dioxide and water do not combine to make sugar when you merely mix them. Doctor Spoehr has not succeeded in persuading them to do so by any of the thousands of experiments he has tried.

It is certain, Doctor Spoehr thinks, that what goes on in the green plant is not a simple chemical reaction, easy to duplicate. It is very complicated. It involves several distinct chemical reactions going on side by side; and at least one of these reactions is related closely to the actual

life of the plant. Dead plants are no good for photosynthesis.

If we are to duplicate what the leaf does, it will be necessary, Doctor Spoehr believes, to concentrate on this problem the best efforts of many scientific specialists, of physicists and biologists, of experts in radiant energy, and of chemists. That is why the official committee of the American Association was authorized.

The scientists who undertake this investigation will have the task not only of doing at least as well as the plant does. They will have to do far better, for the work of the plant is extremely inefficient. Of the tremendous amount of solar energy that falls each day on the earth's surface, plants use only the tiniest fraction, probably not more than one thousandth of it, even in the tropics, where the growth of vegetation is at its best. Any process for the artificial making of sugar by sunlight must show a far higher efficiency than this or it will never be really useful.

Scientists are confident that this will be possible. Chemistry has bettered Nature's processes often before. Indigo, for example, was formerly a plant product. Now

it is made better and more cheaply in the chemical factory.

It is by no means impossible that before very many years we shall see factories for artificial food, as pictured on this page, springing up in desert areas where sunlight is unusually strong.

But these factories will be sugar factories only; they will not make motor fuel for us. It is true that the sugar might be made into alcohol, but the only way to do this is by means of yeast, and yeast has to work in water. How are we to separate the alcohol from the water?

This is done ordinarily by distillation, but distillation requires more heat than the fuel value of the alcohol you produce—a fact frequently forgotten by the persons who theorize about the possibilities of alcohol for fuel.

Probably a better solution will be some way of using the sun's heat directly for distillation, or perhaps a method of making alcohol or some other combustible liquid out of sugar by a dry process, without using yeast at all.

How these problems will be solved, only time can tell. In any event, the work of the committee appointed in Boston holds as much interest for the general public as it does for the professional scientists.

An Amazing Night Photo—Rivaling the Stars

THIS extraordinary nighttime photograph of the Los Angeles district of California, taken from the slope of Mount Wilson, illustrates two recent and striking achievements of science.

First, it marks the perfection of a photographic plate that will faithfully record the twinkling of millions of electric lights, like so many stars, in a panoramic view embracing a territory 40 miles square.

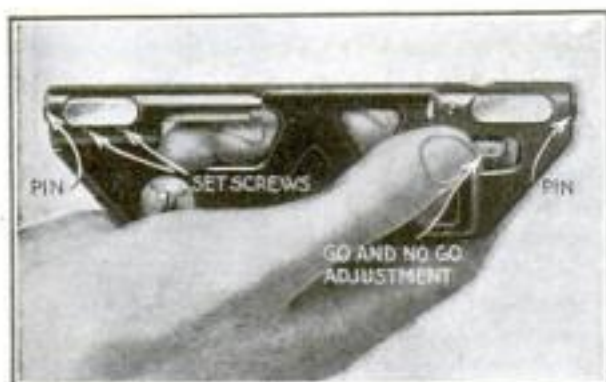
And, second, it illustrates the extreme sensitiveness of a reflecting galvanometer by which Dr. C. G. Abbott of the Smithsonian Institution and other scientists at the Mount Wilson Observatory have succeeded at last in measuring the feeble heat sent to earth by distant stars. Detecting a hundred millionth degree of temperature and a trillionth of an ampere of electric current, this marvelous instrument is instantly disturbed, Doctor Abbott tells us, when any one of the countless city lights shown in the view on this page and page 35 is switched on!

Working with the 100-inch telescope at Mount Wilson Observatory, Doctor Abbott and his colleagues have found that the sun's heat on 20 square feet equals one horsepower. The heat of all the stars equals 250,000 horsepower.



Taken from the slope of Mount Wilson, in the foreground, this remarkable nighttime photograph of the Los Angeles district, Calif., includes the lights of homes, streets, boulevards, and automobiles in a dozen cities and towns

Pin Gage Measures Diameters of Holes



Turning a thumbnut tests hole

AN ADJUSTABLE limit, pin production gage for measuring internal diameters, combining a "go" and "no go" gage, consists of a trussed casting with a movable pin at each end. One pin is locked according to the dimensions of the hole to be tested. The other, controlled by a thumbnut, slides in and out a distance that represents the inside and outside limits allowed.

The gage is placed in the hole to be measured and the thumbnut turned to determine whether the diameter comes within the "go" and "no go" limits.



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Police Carry Small Tear Gas "Riot Guns"

A SMALL tear gas dispersing apparatus, designed for use in quelling riots, has recently been adopted as part of the equipment of the Washington, D. C., police.

It consists of two tanks, one for compressed air and the other for the liquid that upon release forms the tear gas. The compressed air is permitted to escape through a nozzle, carrying a small amount of the tear gas with it. This forms a fine mist that causes any one who comes in contact with it to weep profusely.

Rotary Broom Sweeps Railway Tracks

TO KEEP dirt and trash from the rails—a primary necessity for proper working of signals and for inspection of rail bondings—the Pennsylvania Railroad has developed a labor saving track sweeper for use in mountain sections.

The sweeper consists of a rotary steel broom three feet in diameter, mounted beneath an old flat car on special hangers that allow it to be raised or lowered at will. The broom turns at about 100 revolutions a minute

and is chain driven from a gasoline engine on the deck. A steel pan receives the sweepings from the broom and deposits them on a belt conveyor, which carries them to a hopper from which the dirt can be dropped at any convenient location.

The track sweeper is drawn by a small locomotive, and its capacity is sufficient for the sweepings from a mile of track. The car has noticeably cut maintenance cost by the elimination of hand labor.



Above: How the rotary steel broom is mounted beneath a flatcar. The two views below show a section of railway track before and after sweeping. Note how thick layer of dirt and trash has been removed



Do Fat People Die Early?

YOU have often heard that excessive fat shortens a person's life. Is this a scientific fact? And if so, why? The truth about surplus flesh and its effect on the machinery of the human body will be told in next month's issue by Dr. Eugene Lyman Fisk, medical director of the Life Extension Institute.

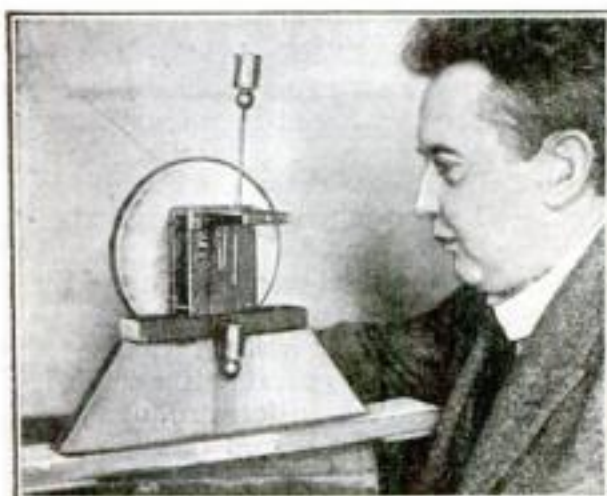
Los Angeles Hampers Astronomers 20 Miles Away



Immediately at the foot of the mountain is Pasadena, while the long patch of brilliant lights in the distance is Los Angeles. At the top along the coast are six beach towns

Thin threads of light joining cities are from automobiles on boulevards, while streaks of light in the sky at the right are the roving beams of a searchlight

Tickless Clock Eliminates Noisy Escapement



Rear view of the silent, tickless clock, showing balanced pendulum

A TICKLESS clock that may eventually replace the present type of timepiece with its noisy anchor and escapement regulators, has been perfected recently by a German engineer, Heinrich Schieferstein.

The invention is the result of study of oscillatory power as obtained from the motion of a pendulum, converted into rotary motion by transmission through a series of springs and wheels. The turning of the hands of the clock is accomplished by a weight that operates a gear wheel. Before this wheel can turn the hands, it must overcome the resistance of a smaller wheel geared to it and connected with the swinging pendulum by a connecting rod hinged to the smaller wheel and fastened to the pendulum.

As the power transmitted by the weight to the pendulum is constant, as in the length of the pendulum, the time consumed in one to-and-fro movement of the pendulum remains always the same. Therefore, the crank on the smaller sprocket is allowed to turn regularly by the pull of the weight and the regulating action of the pendulum and the hand wheel turns around at a definite rate, moving the hand through the space of a minute on the dial in exactly a minute's time.

Figures Show Amazing Radio Growth

THE marvelous increase in the use of radio in the United States was strikingly revealed in a recent announcement from the Federal Bureau of Navigation that the number of broadcasting stations jumped from three in October, 1921, to 564 in November, 1922. Amateur stations during the same period in-

creased from 11,000 to 16,465. Receiving stations throughout the country are numbered at 1,000,000.

In making this report, David B. Carson, commissioner of navigation, advocated constant supervision of broadcasting to avoid hampering radio's usefulness and to foster development.

Electric Voting System for Congress

ENABLING all members of Congress to vote simultaneously, simply by pressing buttons at their seats, an ingenious electrical parliamentary voting system, invented by Marshall F. Thompson, of Washington, D. C., was tested and approved recently by members of Congress.

The vote of each member is shown by means of colored lights that flash opposite the names of members on indicator boards.

Further, a complete perforated card record of individual votes, including total votes, can be obtained by inserting a card in a recorder cabinet and pressing a button.

At each seat is a cylindrical stand, in the top of which are four buttons and a lock. Pressure on one of the buttons records a vote of "aye;" a second, "nay;" a third, "present, but not voting;" and a fourth permits correction of a vote.



The complete electrical ballot system, showing button holders at members' seats, indicator boards with names of voting members, and perforated card recording mechanism

Gun Strap for Hunters Quickly Released

ALMOST every hunter has wished for some kind of a strap that would support the weight of his gun, yet would not interfere with quick action when game was in sight. J. R. Turner, of Sparks, Nev., is now credited with the invention of just such a strap, equipped with an ingenious quick-release snap.

Attached to a gun-supporting belt that is slung about the hunter's shoulders, the

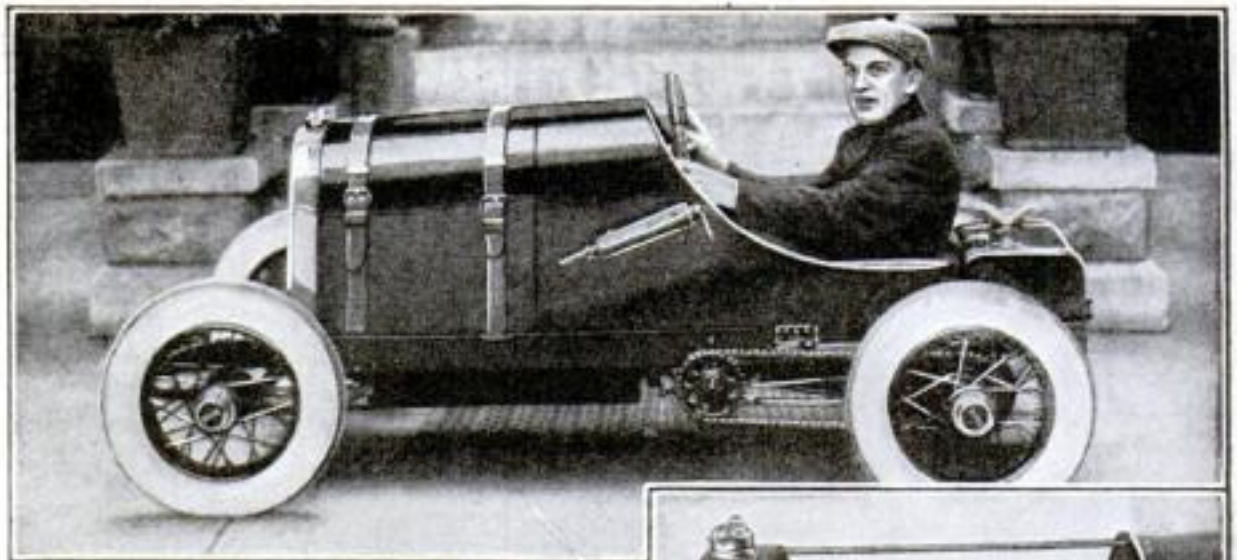


Pressure on lever releases gun

snap encircles the rifle at its center of gravity and is provided with a catch that can be released readily with either hand when the hunter is ready to bring the gun into action. The release is accomplished by pressure on a lever, when the snap drops away from the gun.

The rifle or shotgun drops into the hunter's hands in a convenient position for firing.

With a little practice, the hunter can release his gun in an instant.

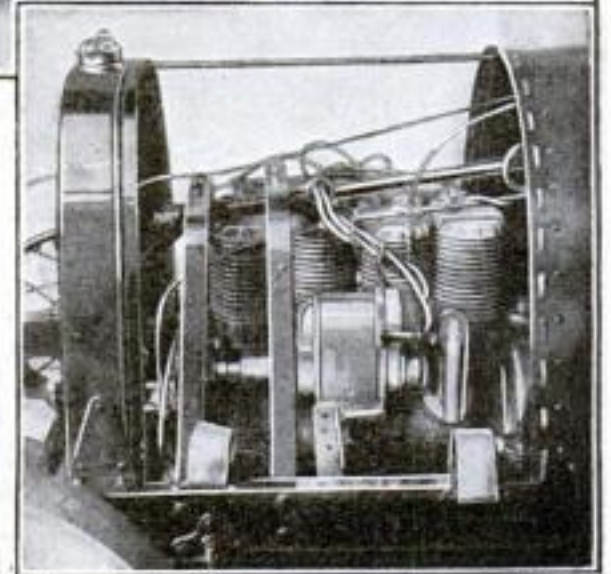


Baby Cyclecar Speeds at 80 Miles an Hour

A DIMINUTIVE one-man sport car, said to attain a speed of 80 miles an hour and combining the advantages of larger cars, is equipped with a three-speed transmission and a powerful four-cylinder air cooled engine.

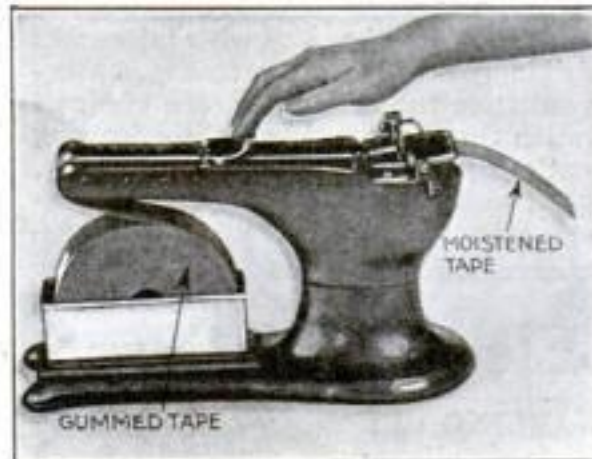
The clutch is controlled by a pedal and gear shifting by a short lever. The transmission drives to a jackshaft and thence by side chains to the rear wheels. Brakes operated by lever act on the rear wheel drums.

The entire car weighs 800 pounds and clears the ground by only six inches.



The diminutive car, weighing only 800 pounds, and its powerful four-cylinder air cooled engine

Package Sealer Moistens Gummed Tape



AN IMPROVEMENT in the use of glued paper strips to replace cord in tying packages, is found in an appliance that enables the operator to unroll a desired length of the tape, moisten the glued side, and place the strip upon the package without soiling his fingers.

The dry roll is placed on a spindle and the loose end is carried over the top of the device, passing through a catch and over a moistening roll. To operate, the catch is pressed down and drawn forward, carrying the tape with it as it passes through the moistener.

Motor Truck "Delivers" Portable Amplifier

A POWERFUL amplifying apparatus with six-horn loudspeaker, devised so that it may be carried complete in every detail on a specially equipped motor wagon and moved rapidly from place to place, is now in use in New York City and vicinity for amplifying addresses by noted men.

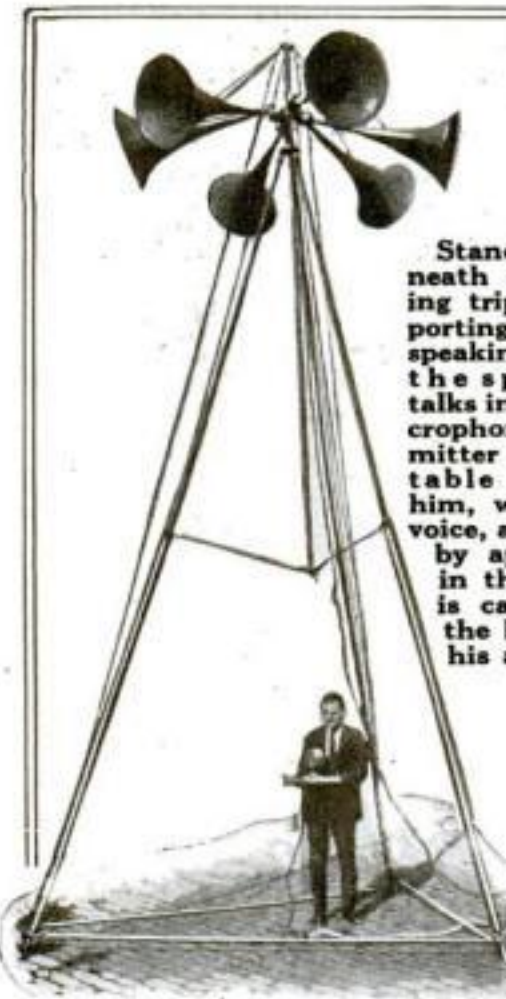
The motor wagon carrying the amplifier is parked as close as possible to the speaker's stand. Wires connect the amplifier with a microphone transmitter placed on the table within eight feet of the speaker. The speech, amplified by equipment in the wagon, is carried to the audience by six loudspeaker horns which are elevated by a tripod.

All the electric current for the apparatus, including that used in illuminating the wagon and for small power tools, is drawn from storage batteries. Wiring is arranged for plug connections.

The control panel of the system, on

which amplifying vacuum tubes are mounted, is placed on rubber pads and suspended from spring arrangements which check vibration, thus protecting the tube filaments. All extra parts are carried in specially built felt-lined cabinets.

A specially designed cover for the top, sides, and rear end of the car is arranged so that it may be raised and used as an awning.



Standing beneath a towering tripod supporting six loudspeaking horns, the speaker talks into a microphone transmitter on the table before him, while his voice, amplified by apparatus in the truck, is carried by the horns to his audience



How the motor truck amplifying apparatus is hooked up to the speaker's stand and to the loudspeaking horns

Basket-Like Cave Stairway Built without Rivets

TWO hundred feet below the earth's surface in a deep cave in Calaveras County, Calif., stands an extraordinary example of modern electric welding—a steel tower 100 feet high and seven feet in diameter, containing neither bolts nor rivets, yet so rigid as to provide a firm support for a spiral steel stairway which it incloses.

A delicate web of steel ribs, ingeniously woven together, the cylindrical spire appears to the casual observer to be so fragile that a vigorous push might shake it to pieces; yet in actual tests, six men, jumping on the stairway, were unable to topple a silver dollar placed on edge on the top step!

High Ledge Is Starting Point

Rising like some unearthly growth in the midst of grotesque forms that populate the gloom of cavern walls, this rivetless steel basket affords the one means of descent to the cave floor. From an outside entrance the cave is reached through a long, narrow passageway terminating at a ledge in the cavern wall, 100 feet above the floor. This ledge was the starting point from which the welded tower was constructed. Formerly a somewhat perilous descent from the ledge to the floor was accomplished by means of a long rope and hand operated windlass.

Because of the difficulties of carrying materials through the narrow passageway to the construction site, the use of riveted angle-iron construction was out of the question. But these difficulties were overcome by ingenious design and the invention, by a Stockton, Calif., engineer, of unusual electric arc welding methods.

On the high ledge was built, first, a reinforced concrete landing platform, from which two short I-beams extended horizontally, like arms, into the cave. From these anchor arms four steel cables were lowered to the cave floor, and an electric hoist was

installed to raise and lower workmen and materials.

To the cables were then welded a series of steel hoops at intervals of 10 feet, by the following method: At equal intervals around the outside circumference of each hoop were fastened four short pieces of pipe through which the perpendicular cables were threaded. Thus, by pouring babbitt into the pipes, the hoops and cables were firmly joined.

The cylindrical framework constructed in this manner was anchored to the cave floor by burying the cables in a block of concrete. The basket-like tower was then built up from the bottom. Between each 10-foot section of the frame thin, flat strips of steel were bent into spirals and woven together in the form of a lattice, each strip making one turn around the tower in the 10 feet. Where the strips crossed they were welded to each other.

In place of one of the spiral strips, double strips heavier than the rest were placed to support the steps of the spiral stairway, one end of each step being welded to them. The other end of each step was welded to the core of the tower, consisting of 10-foot lengths of seamless steel tube welded together.

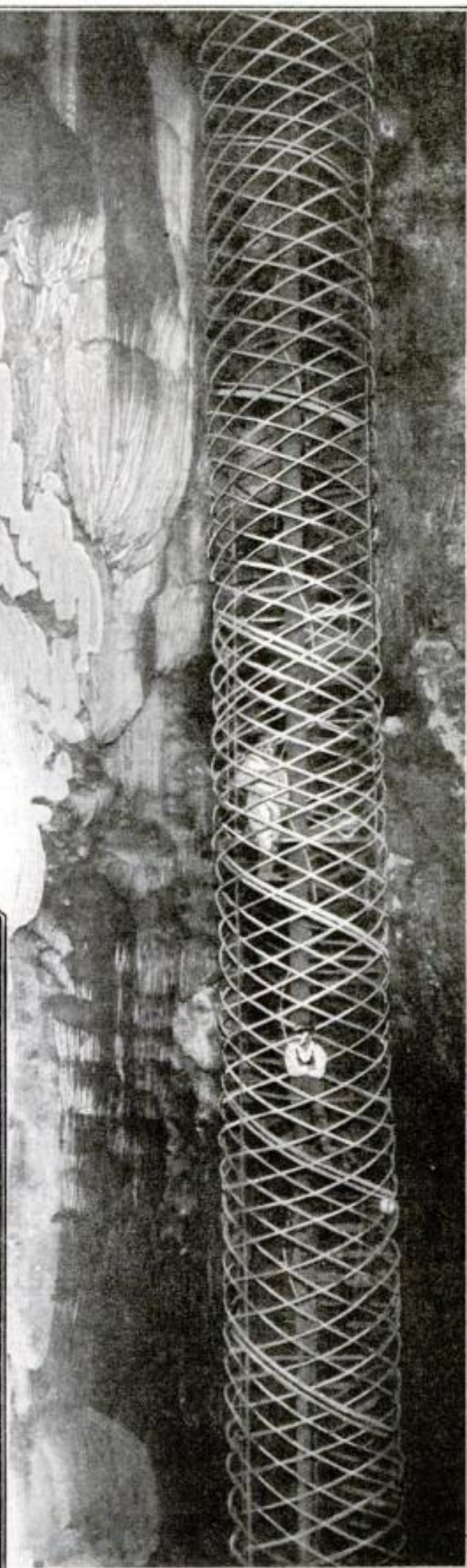
Besides supporting the stairs,

the hollow central core is used to carry fresh air into the cave and to inclose electric light wires.

In all, there are 7221 welds in the three tons of steel that make up the tower, representing five weeks of labor.



The base of the welded tower at the cave floor, showing entrance to stairway. Note how flat steel strips, bent into spirals, and interwoven about a framework of cables and hoops, are welded together to form a rigid structure



Containing neither bolts nor rivets, this electrically welded cavern tower, 100 feet high, supports and incloses a spiral stairway leading to the cave floor

What Kind of Exercise Do You Need?

"Keep Your Neck and Abdomen Strong and You Can Count on a Fifty Per Cent Longer Life than the Average Man"

AMERICA is a land of the physically unfit. And one important reason for this is that Americans do not and will not take enough of the right sort of exercise.

Do you really know what is the right exercise for you?

I once wrote a prescription for a prominent banker who vowed that he would not exercise. That prescription, one of the best I ever wrote and one that helped make him whole again, was simply:

"A cane and a dog to be taken daily on a walk for an hour before meals."

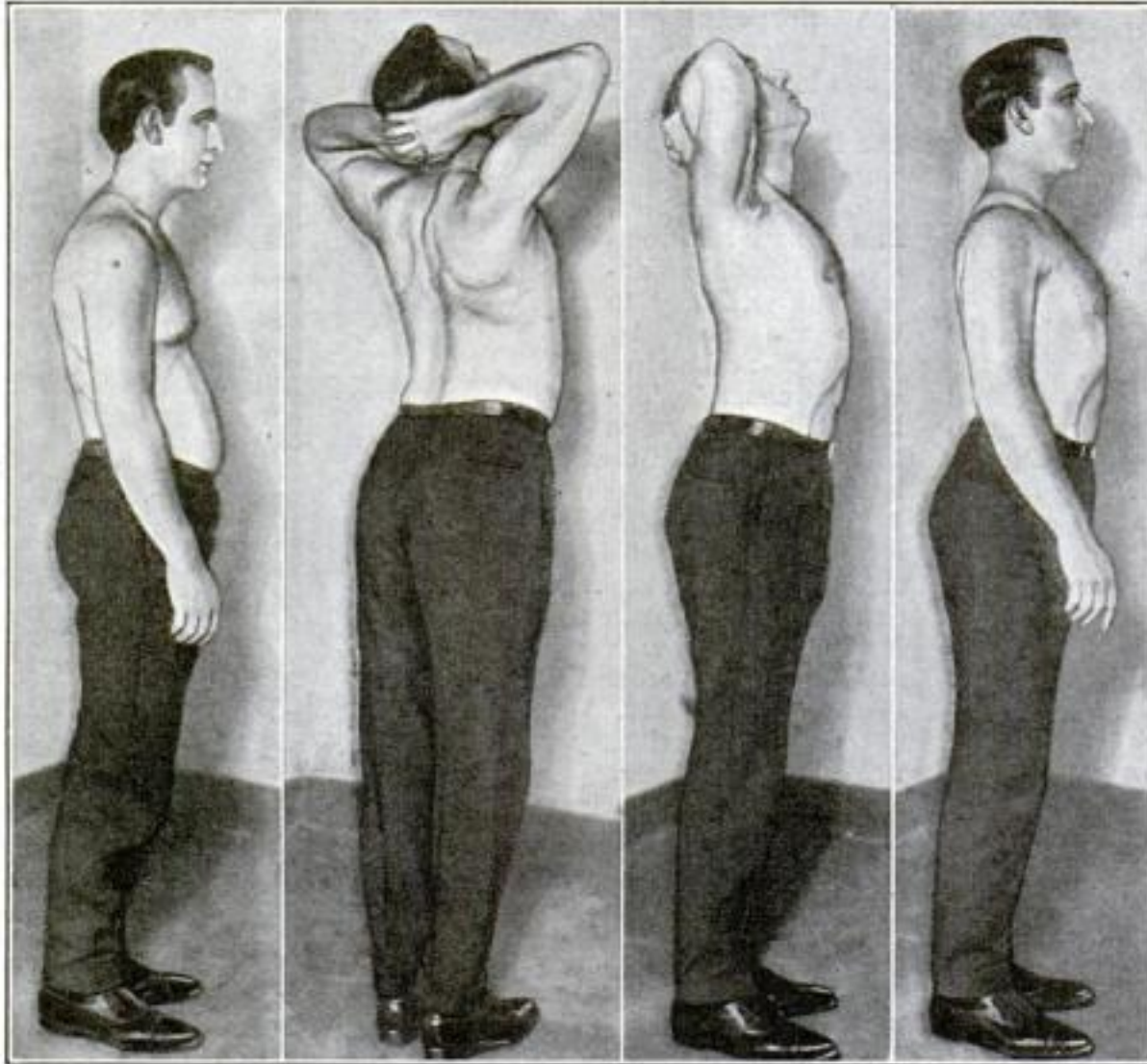
Physical Failures

I'd like to prescribe exercise of a different sort for the fellow who says:

"Exercise? I get enough exercise in my work. I go to bed tired enough at night. Don't talk to me about exercise. I'm too busy."

"Quite so, my friend," I'd like to say to him. "You are the kind of man who was thrown out by doctors in the draft—one of the 40 per cent Americans not fit to fight. We all know you. You are not patriotic enough to keep one and only one citizen in good condition. You are the reason for the recent man-power conference at Washington, where the Secretary of War, John W. Weeks, called us to consider the physical deficiencies of American manhood as revealed by the figures of Surgeon-General Ireland, and to devise remedies for

By Dr. C. Ward Crampton
National Authority on Exercise



Typical careless posture which the article explains is common to most of us, causing hollow chest, drooping head, and protruding abdomen. To remedy these defects the "star gazer" exercise, shown here, is recommended.

The "Star Gazer" Exercise

THESE photographs were posed for POPULAR SCIENCE MONTHLY under the personal supervision of Dr. C. Ward Crampton to illustrate the beneficial effect of his "star gazer" exercise, designed to strengthen neck muscles, to straighten the spine, raise the ribs to allow more space for lungs, and tone abdominal muscles.

Try this exercise, observing the following "counts":

Position: Standing, hands behind the head (not on the neck).

1. Head forward, chin to chest.
2. Head up, "looking at stars."
3. Head back, chest up, abdomen in; don't lean back from the hips.
4. Head back as far as possible. Try to look at the back of your neck.
5. Press up with hands and twist head first to the right, then to the left.
6. Repeat No. 5.

Correct posture—head up, chest high, abdomen in. The position should be natural and easy. Shoulders should not be forced back. You will fall into it more naturally if you practise the "star gazer" exercise.

from the labor activity, of whatever nature that labor may be. Its chief benefits accrue after the exercise is over. Exercise causes waste, but it stimulates and cleans the tissue. Rest immediately thereafter provides opportunity for repair and up-building, restoration and readjustment.

the alarming prevalence of physical decadence."

If you don't believe that I am right, just consider the report issued by the Carnegie Institution in collaboration with Lieutenant-Colonel A. G. Love, of the United States Army Surgeon-General's Department. The report shows that 500,000 men were rejected by draft boards on physical grounds. About 2,000,000 recruits who were examined at military camps, were found to be physically defective.

Rather a sweeping indictment of American physique, is it not?

What Is Exercise?

And what is to be done about it? Proper exercise is one of the answers.

At the outset, we must admit that exercise is a vague term. It may mean anything from flexing the fingers to playing football. Where the movements are the same or constantly repeated, muscular activity, of course, wears down. This is labor. Exercise, on the other hand, is activity used to stimulate repair and growth. It provides variety, a relief

Five Simple Ways to Test the Fitness of Your Body

These energetic figures, drawn by Doctor Crampton, illustrate a series of tests by which, he says, you may gage your anatomical condition



1. Stand with legs straight and touch your toes



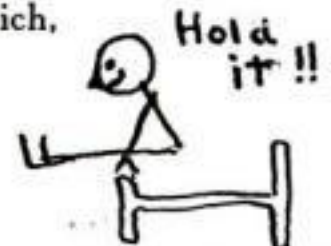
2. Sit with legs stretched out straight and touch your toes



3. Bend back from knees, touching floor with your head and forming a bridge



4. Lying on floor, curve your body and legs so that feet touch behind head



5. Stretch legs forward horizontally while supporting your body with hands. Hold it 10 seconds

Three Types of Good Physique



Jack Dempsey, Champion Boxer

"AN OVERSIZED man with big muscles and large organic equipment. Too big and too much muscle for ordinary occupations. Fighters need much physiological exercise, both of low and high speed. Frequently they become stale solely because they lack variety in the psychological side of their occupations"

Different kinds of exercise produce different results. The bookkeeper, for example, doesn't need the same exercise required by the salesman; the mechanic needs exercise as much as the teacher; and even the postman who does nothing but exercise (as we usually consider the term) needs planned exercise. Just as our bodies need many varieties of food to obtain in proper quantities the five elements of food—fats, carbohydrates, proteids, vitamins, and salts—just so do we also need each of three elements of exercise.

The Three Elements of Exercise

Considered scientifically, these three elements of exercise are: *Anatomical*: For correction and improvement of the body structure. An illustration of this is the coal-heaver's arm and hand. Grasping the shovel handle as he does and working his muscles at the same time, the muscles tend to keep the fingers cramped in a grasping position, and it is difficult, if not impossible, for him to straighten them out. Similarly, he cannot completely straighten the arm because of the shortness of the biceps muscle.

Physiological: Stimulating organic activity. An amazing number of persons, either through lack of all exercise or too little exercise of the right sort, have allowed their intestines to stagnate, their nervous systems to get "on edge," and their hearts to become tired through overwork.

Psychological: Interest, enjoyment, and fun. It is quite true that while you may be getting adequate exercise, you may lose its benefits just because it fails to interest you. The trouble with many men and women is that they do not know how to play when the day's work is over. Psychological exercise containing elements of in-

**Georges Clemenceau,
Champion Statesman**

"AN ALL around man. The first citizen of France, who does his regular morning exercise and takes his walk every day. He knows how to fight, how to rest, how to work, and how to stop working. He finds it worth while to keep fit"



terest and enjoyment is what they need.

Having outlined these three elements of exercise—*anatomical*, *physiological*, and *psychological*—as standards, let us find out just why we need each one of them.

Practically all of us need more anatomical exercise. Why? How many men, women, and children have you seen with hollow chests, sloping shoulders, drooping heads and protruding abdomens? Unless you are a physical exception, at least two of these defects and possibly all of them, appear in *yourself* to some extent. This means that something is wrong anatomically. The structure of your body has developed faults—mechanical distortion or displacement of body parts caused by lack of exercise. And the result is that your vital organs are cramped and depressed. Exercise that will put them back in their proper places and keep them there is required—exercise that will lift the head, strengthen the neck, raise the chest, straighten the back, and flatten the abdomen.

Faults Corrected by "Star Gazing"

There is one exercise for the back of the neck that every one needs because every one's head is balanced, not in the middle, but toward the back of the skull. To correct the natural tendency of the head to pull forward, one of the most valuable exercises is that described and pictured on page 38 as the "star gazer" exercise.

The purpose of this exercise is to shorten and strengthen the muscles of the back of the neck which tend to elongate and weaken, causing the head to droop.



**Wladek Zbyszko, Champion
Wrestler**

"TESTED by the writer in George Bothner's gymnasium in New York City, and discovered to be one of the few men ever found in perfect condition. A marvelous frame made up of tissues of extraordinary quality. An exceptional type of wrestler. Although he is tremendous in size, he is not muscle bound"

The same principles of shortening and strengthening muscles are applied to straighten the spine, to lift the ribs and thus make the chest more capacious, to tighten up the muscles of the protruding abdomen, and, in general, to make a man well toned instead of flabby—with a permanent high chest instead of a cavity where his chest ought to be.

If a man can keep his neck and his abdomen strong, he can safely be guaranteed a 50 per cent longer life than the average man, with 50 per cent more efficiency and 50 per cent less disease and pain.

"But how," you may ask, "can I determine whether my neck and abdomen are strong?"

How to Test Your "Fitness"

To help you answer that important question, I have devised the series of exercises illustrated at the bottom of page 38. They are direct gages of your condition, and if you will first study, then practice them, you will be able to readily determine just how you stand physically. Furthermore, you will be fit as long as you are able to pass these anatomical exercise tests.

But don't fool yourself by thinking that just because your anatomical structure appears to be right, you do not need exercise! Many a man holds his head high and his back straight by virtue of heredity or early training; yet he may be seriously lacking in vitality and quite as weak as the man who is structurally distorted. Such a man is like the auctioneers' clock "with a beautiful onyx front, but no works to speak of." Nine tenths of American men and women over 40 are in this position. Outwardly, they appear sound, but, if called upon to chase a car or run a hundred yards from danger, they would damage

What Is Your Job? Here Are the Right Exercises for You

Prepared by Dr. C. Ward Crampton, National Authority on Exercise

Pick Out
the Class
of Work
Most Like
Your Own



Typical
Deficiencies

Corrective
Exercises

Scholar

Stoop shoulders; hollow chest; weak muscles; small, weak heart. Thinks play is trivial and gradually "dries up"

He Needs:

Vigorous setting-up exercises each morning and evening. Daily walk for 45 minutes. Heavy "workout" three times a week. Weekly half-day recreation out of doors necessary

Machinist

Chest bound by excessive muscle work. Large muscles; limited organic power; cramped internal organs

He Needs:

Daily setting-up exercises necessary for neck and anatomical correction. Twenty-minute walk each morning and night. Boxing and wrestling twice a week. Weekly half-day hike out of doors

Postman

Body slumps from constant wear. Abdomen weak and bulging; muscles, heart, and other organs worn, but sound within limits. Psychologically weary

He Needs:

Setting-up exercises each morning and evening vital to correct slump. Walking not needed for exercise. Heavy workout necessary twice a week for short periods. Should stay indoors for weekly half-day

Laborer

Muscle bound; slumps from weariness; abdomen weak. Bodily organs tissue bound by work; lose elasticity; too hard in spots; too soft in others. Tired, stolid

He Needs:

Abdominal muscles especially require daily setting-up exercises. Daily walk may be omitted if work is in fresh air. "Heavy workout" not needed. Should go out of town and recreate half-day weekly

Office Executive

Chest stiffened; abdomen bulging; FAT "has-been"; muscles weak; heart small and weak, or large with hard arteries; organs soft. Psychologically too serious and too tense; lacks real fellowship

He Needs:

Daily setting-up exercises morning and night essential. Daily walk necessary, at moderate pace. Moderate workout of game type twice a week vital. Two half days out of doors at golf or its equivalent

themselves seriously and perhaps even die from the effects.

To rebuild their "workings"—the heart, lungs, and digestive organs—these persons need physiological exercise, starting with the lightest form of this exercise and gradually increasing it until a splendid mechanism is restored, available for use in every reasonable emergency and enduring for a long, useful, and happy life.

One of the most striking examples of the auctioneer's clock type of citizen was a patient of mine who had played football on one of the great college elevens with such success that for two years he was named as the All American full-back. He was a splendid fellow—six feet two, 190 pounds, head up, back straight, clear eye, and clean skin, with a fine war record behind him. Yet I found that his blood pressure record was 60 per cent of normal, and the general index of his physical condition only about 50 per cent. Corroborating these proofs of deficient internal condition, was a soft layer of ease-grown fat distributed evenly over his splendid frame. I sent him to a gymnasium, and visited him at his work two days afterward. He complained of the "childish" exercises that I gave him, recalled his athletic record, claimed to be in fine shape and wanted to play handball.

He needed a lesson. So I gave him a fair competitor and watched him play handball for five minutes. Then I took his pulse. His heart was throbbing wildly at the rate of 162 beats to the minute. He was soft in-

side as well as outside. His heart and his blood circulation system were out of training. He needed physiological exercise, but not of such intensity.

What happens when we exercise? Let me explain that muscular contraction in



A Physiological Test

"RUN" in one spot, 90 steps to the half minute, raising heels to touch hands. Your pulse should return to normal one minute after

exercise calls upon the circulation for more blood. In a muscle that is being exercised, the blood content is increased from four to 10 times, depending on the kind of exercise. Contracting muscles draw on the blood for oxygen, and they want it quickly. As a result the entire blood circulation mechanism is stimulated. The heart beats faster, the blood pressure rises when the splanchnic veins in the abdomen (in which the blood was previously stored) contract, and the whole body machinery is whipped up and readjusted.

The ductless glands throw out secretions known as hormones, which enter circulation and act as messengers to the various organs, coordinating their activities. Preparations are made for drafts on the most available food supply from the glycogen and the liver. Breathing

becomes more rapid to supply air to the blood and to prevent the accumulation of carbon dioxide in the body. The lymph channels become more active, cleaning up the muscle waste as the exercise continues. In short, the whole set of body organs is speeded up.

If the exercise is vigorous and the body machinery in good order, the initial distress of activity gives way to a feeling of comfort and pleasure in movement and power. You may recognize this feeling as "second wind." But if the machinery is unused to hard work, there results trouble, waste, and strain. In other words, the body, when the machinery is not in good order, is organized for only the lightest work, has no margin of power, and when called upon for activity, falls into hurtful disorder.

Danger of Over Exercise

Everybody needs physiological exercise to keep the body machinery in health, with a margin of power for reasonable emergencies. Yet we must be careful not to over exercise and thus wear out the bodily machine. Scientific investigation tells us that the best physiological exercises are those that are the most natural and in which the muscles act in their most accustomed ways. These are exercises of the large muscles rather than small ones. Walking, dancing, running, climbing, swimming, boxing, and playing active games are often the most useful ways of getting physiological results.

The postman is a good example of the man who needs physiological exercise. True, in continuous walking he gets a certain form of this exercise. Yet while his organs are working in a going concern, they may not be able to support him in vigorous exercise like running.

(Continued on page 41)

His equipment, in other words, is effective up to a certain low limit of strain. What he needs is physiological exercise that will increase his limit.

On the other hand, the tired business man who never "raises a finger" needs all kinds of exercise.

To determine your physiological efficiency, test the reaction of your pulse after "running" 90 steps to the half minute on one spot. In running, the heels must be raised to touch the hands, as shown in the illustration at the bottom of page 40. Note your normal pulse beat before the test, its rate afterward, and the time it takes the pulse to return to normal again. This interval should not be more than one minute.

Why Men "Go to Seed"

We now come to the third and last element of exercise—the psychological. Many men go to seed mentally, morally, and physically because they do not know what to do with themselves at the end of a hard day's work. They never have learned how to play, and they do not know how to have a good time except in some crude, destructive fashion. They take no exercise because the only exercise they know of is some advertised course of movements that they would have to do alone, without the zest of changed environment or friendly competition. It's no fun. If they could have some pleasure with their exercise, they would exercise.

The exercises that are enjoyed most are those that nature approves for us. Nature wants children to run and jump, play hide-and-seek, climb, throw, and swim. And they do these things if we permit them. Once Nature insisted that man, if he would live, should fish, hunt, and take many beneficial outdoor exercises. That's why we still like to hunt, fish, swim and ride horses, bicycles, automobiles, and aeroplanes.

Baseball Fan Gets Exercise

Nature, too, wants children to stand up for themselves. Hence she encourages competitive games, full of dares, trials of speed and courage. We all like a contest. Nothing will draw a crowd as quickly as a fight.

Thirty thousand men watching a handful of baseball players in a big league contest are indulging the competitive instinct and participating in the struggle. When Babe Ruth slams a homer, every man of the 30,000 participates in the glory of it. This is pure psychological exercise, without bodily exercise except cheering; although a very definite anatomical exercise occurs at the seventh inning when every one of the 30,000 stands up, contracts the muscles of the back and neck, straightens the dorsal spine, and lifts the ribs—a very natural and very effective structural exercise.

The contest idea is responsible for golf, which is low in physiological value compared with more strenuous games, but high in psychological exercise value, because a keen desire to "beat the other fellow" is combined with walking and swinging the arms and body.

To keep physically fit, every man needs a balanced ration of exercise—enough of the anatomical, physiological, and psychological to make the strengthening of muscles and the correction of body structure play rather than work for him. The subject of exercise is as many sided as life itself—a fascinating, scientific study. It is coming into a larger service as more scientific men enter the field. And wise is the man who keeps himself in 100 per cent working order.

History Recorded by Giant Tree

Courtesy Natl. Park Service

MILEPOSTS in the world's history for almost 1000 years are marked by the growth rings on a cross section of one of the giant Sequoia trees of Yosemite National Park, recently uprooted by a storm. To demonstrate the tremendous age that the great Sequoias attain, Ansel F. Hall, the park naturalist, has marked on the cross section of the tree those rings that measure the growth of the tree at the time important historic events were occurring.

Although the tree was 14 feet in diameter at the base, it was comparatively young as compared with other Sequoias still living. One of these, the Grizzly Giant, is 29.6 feet

wide at the base and its age has been estimated at 4000 years.



1860-CIVIL WAR
1776-DECLARATION OF INDEPENDENCE
1620-LANDING OF THE PILGRIMS
1492-DISCOVERY OF AMERICA
1215-MAGNA CHARTA
1066-BATTLE OF HASTINGS
A.D. 923

Each ring marking a stage in the thousand-year growth of the Sequoia is labeled to show the most important contemporary historic event

Tailboard Engine Drives Gas Railcar

A GASOLINE motor-driven railcar of novel design, seating 30 passengers, has been invented by A. R. Meister, of Sacramento, Calif., and put into operation on the Hetch-Hetchy Railway.

By placing the motor at the rear of the driving wheels, the inventor has eliminated all revolving parts in front of the rear axle and has done away with the noises and gasoline odor that have proved to be serious drawbacks in other gasoline railcars. The engine is supported through coilsprings at the rear end of an auxiliary frame, extending back of the driving wheel.

The seating capacity has been made unusually large by hanging the car low without lengthening the wheel base.

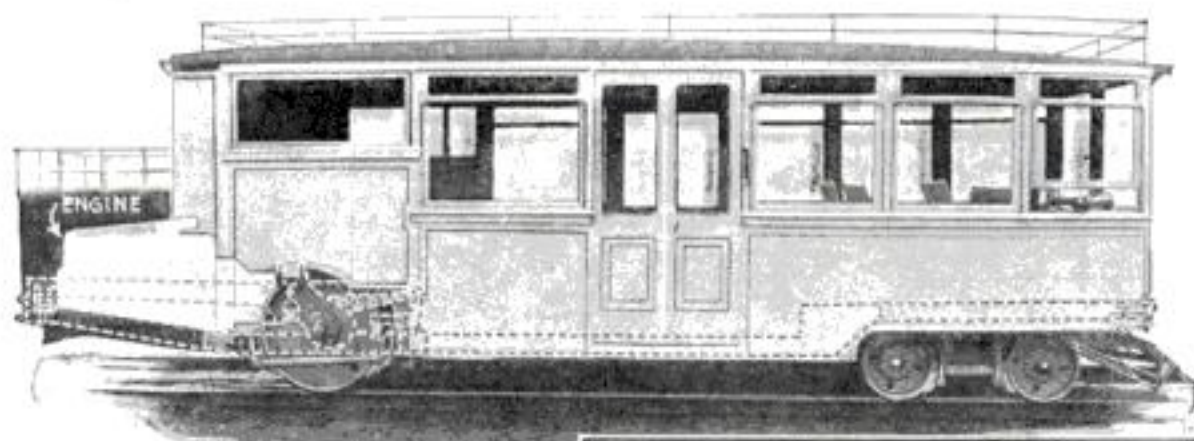
The subframe forms one half of a complete truck, having a swivel bolster built into the main frame so that it turns at

curves, eliminating flange wear and relieving the side thrust. Although the car weighs 10,400 pounds, it is said to make eight miles to a gallon of gasoline. It is also claimed that the car negotiates a five per cent grade 12 miles long with numerous curves at a speed of 27 miles an hour.

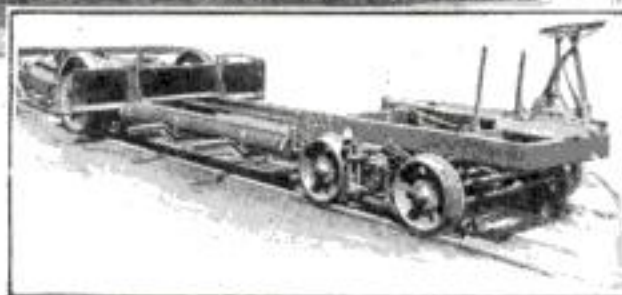
The vibration of the car is said to be negligible.

THE popular idea that it "takes a big man to be a salesman" was exploded recently by a scientific study of the sales records of 600 salesmen, which proved that the most successful selling is done by men of about five feet nine inches tall.

Dr. Harry D. Kitson, of Indiana University, recently presented the findings of this research to the American Psychological Association.



Dotted lines indicate position of the chassis (at right) of the new 30-passenger, motor-driven railcar in operation on the Hetch-Hetchy Railway in California. Note how engine is supported through coilsprings on an extension of the frame projecting at rear



Underground Radio for Mine Rescues

EXPERIMENTS just completed in the United States and England indicate that wireless communication with miners in the underground workings of mines soon will be possible, providing a tremendously effective aid to rescuers when explosions or other disasters trap workmen far below the surface.

Experiments in Mine Cave

Experiments in England were conducted by the Sheffield Wireless Society at the Blue Johns Mine, which is in reality a huge natural cave. An aerial—consisting of a single strand of copper wire—was suspended on insulators across one of the diameters of a "room" of the cave, 10 feet above the level of the floor. A ground connection was made with the instruments by running a bare copper wire a short distance out of the cave, down a tunnel where there was a running stream of water.

The broadcasting station was $2\frac{1}{4}$ miles away and the aerial in the cave 280 feet below ground level. Audible messages were transmitted and received at both ends. In the cave an ordinary spark transmitter was used for transmission, while a short wave tuner with a reaction coil added and a three-stage detector amplifier were used for reception. At the broadcasting station a similar spark transmitter was used, and for reception

a set using one radio frequency amplifier, a detector, and three audio frequency amplifiers. Messages passed freely in both directions.

The experimental coal mine of the Bureau of Mines at Bruceton, Pa., was used in the experiments conducted in the United States. These tests disclosed the fact that with a receiving set at a point 100 feet underground, signals from KDKA station, East Pittsburgh, Pa.,

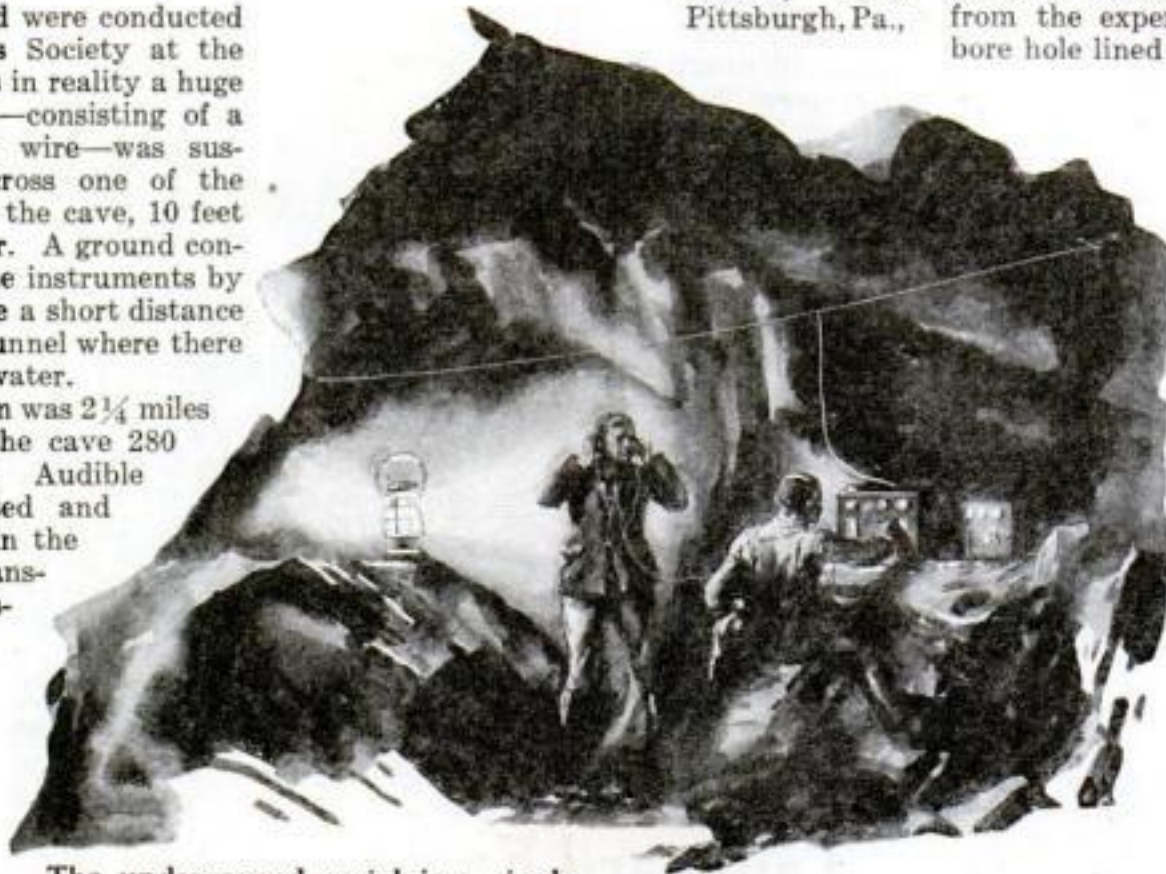


From a broadcasting station two miles distant, radio messages were received 280 feet underground

could be heard. The station is 18 miles from the experimental mine. A six-inch bore hole lined with iron pipe and containing electric light wire 50 feet from the receiving set evidently aided in the reception, for when the apparatus was carried away from the bore hole, signals were barely audible through 50 feet of cover.

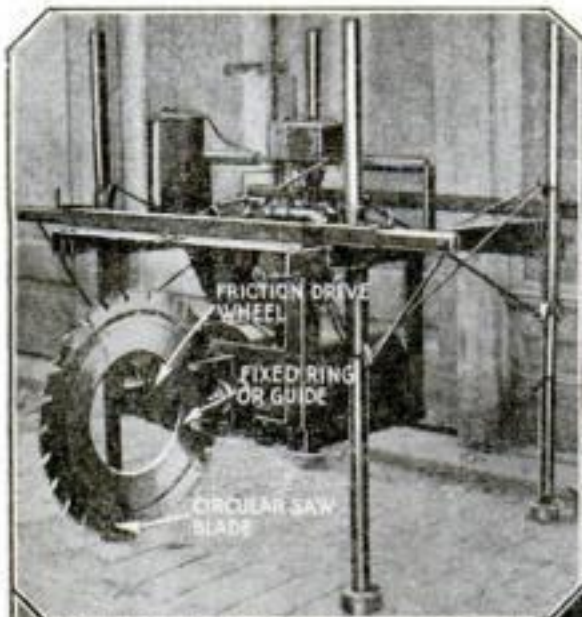
In transmitting through 50 feet of coal strata, continuous waves of from 200 to 300 meters length were used. Experts believe that longer wave lengths will make possible receiving and transmitting messages at greater depths.

In all experiments vertical antennae were used; horizontal antenna gave no results. The strata of the experimental mine lie horizontally and this is believed to have some influence on radio waves.



The underground aerial is a single wire strung across the mine room

Two-Way Saw Fells Trees, Cuts Logs

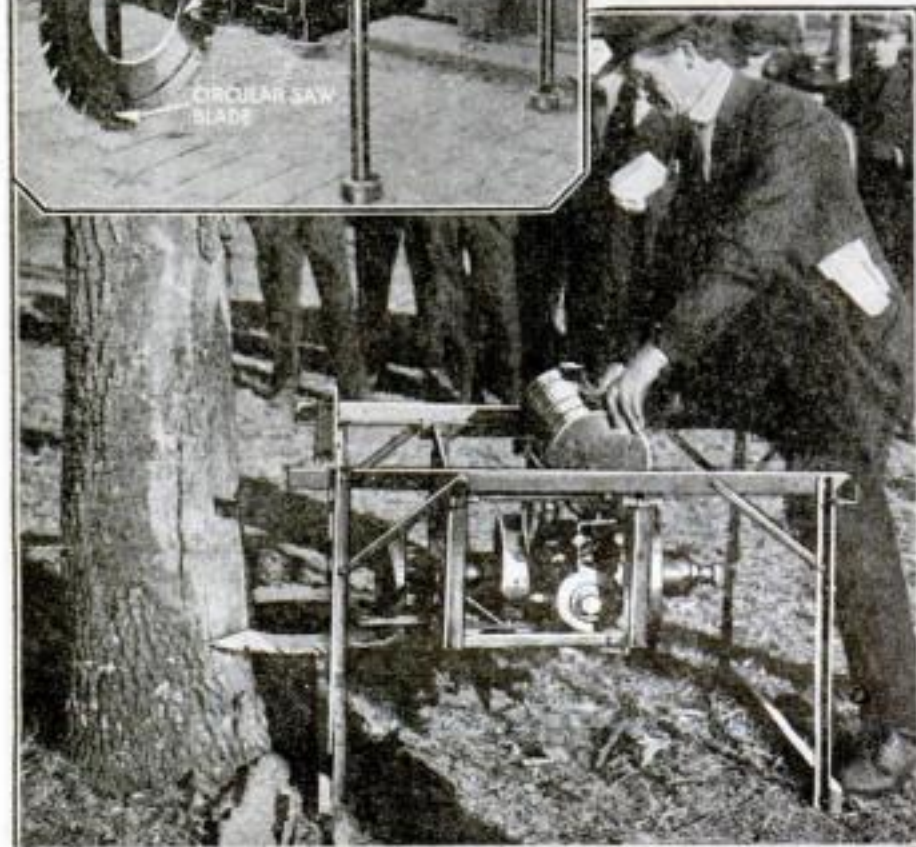


EQUIPPED with a ringlike saw that cuts either vertically or horizontally, a tree felling machine, recently invented by C. V. Fite, of Charlotte, N. C., can be used to cut the tree it has felled into logs of desired lengths.

The engine drives a friction drive which presses against the side of the saw. A fixed ring serves as a guide for the saw and follows the cutting blade into the cut—an operation that is possible because the thickness of the guide is less than that of the cutting teeth. Thus, the machine can fell a tree the diameter of which is three fourths that of the saw. For a tree of greater thickness it is necessary to make several cuts from various points on the circumference of the tree.

The engine, saw, and auxiliary apparatus are mounted on a light frame, the legs of which can be adjusted in length so as to obtain a horizontal cut at any desired height above the ground within the operating radius of the machine.

When cutting logs, the axis of the saw is turned through 90 degrees and in an upright position.



For tree felling, the circular saw blade is adjusted in horizontal position. Inset shows saw in vertical position for cutting logs

Extension Arm for Phone Holds the Receiver

THE strain of holding a telephone receiver to the ear for long periods has attracted the attention of inventors and a new telephone instrument recently placed on the market is equipped with an extension receiver that can be adjusted and held



How extension is attached to telephone receiver and adjusted to the subscriber's ear

stationary in any convenient position, thus leaving the user's hands free.

The receiver, to which the extension is attached by means of a flexible tube, is hung from a bracket attached to the telephone stem, while a ball weight serves to keep the hook down when the instrument is not in use. When telephoning, the user lifts the weight and places it upon a bracket, thereby releasing the hook. The extension is adjusted by bending the flexible tube.

The Year's Greatest Adventure for the Radio Fan— Listening In on Transatlantic Messages

Inventors Talk across the Sea without a Carrier Wave

By Jack Binns

America's most popular writer on radio

TO EVERY radio amateur, especially if he has been bitten by the long distance bug, this springtime promises the biggest and most fascinating of all the adventures that have thrilled him in the past couple of years. It is this:

If he is patient and persevering, and if he learns how to make a few changes in his receiving set, he is going to listen in on two-way wireless telephone conversations across the Atlantic!

A Revolutionary Invention

That promise is made possible by an invention that marks one of the most revolutionary advances in radio since Marconi transmitted the letter "S" across the Atlantic 21 years ago. The invention, known as "side band transmission" was demonstrated to the public for the first time when officials of the American Telephone Company recently spoke from a New York City office building to a group of distinguished scientists in London.

It is revolutionary and astounding in that it does the seemingly impossible—it actually carries voices across the ether without a carrier wave! It is the first germ of commercial transatlantic telephone communication; for it means, among other things, that:

Voices can be carried across the Atlantic by radio on one third the power output that otherwise would be required.

Interference—the clashing of radio waves—is lessened, permitting several messages to be sent at the same time on wave lengths close together.

Two-Way Conversations

Two-way duplex voice conversation across the Atlantic, though not yet attempted, is assured for the immediate future. And when it is tried, it will open a splendid opportunity for radio fans all over the country to test their ingenuity in designing sets that will be capable of producing this wonderful new form of transmission.

But first, just what is "side band transmission"?

Until a few months ago, the so called "side band" radiation that accompanies the modulated radio carrier wave constituted a baffling problem in radio transmission. Then a number of radio engineers began a systematic search for a means to eliminate this interference. They spent weeks of patient research at the great Radio Central station at Rocky Point, L. I., where giant 10-kilowatt vacuum tubes had been especially installed to transmit to observers located at various points in Europe.

The astounding outcome was this:

While successfully suppressing the "side bands," they made the amazing discovery that they could more effectively suppress the carrier waves and transmit on the very



Jack Binns, world famous radio expert, who tells in the accompanying article how you can adjust your receiving set to catch transatlantic radio messages

interference with any other waves in the ether that are close to them in frequency.

In the first experiments, one of the side bands was eliminated entirely by means of filter circuits. The thought then occurred to engineers: "Why use a carrier wave at all?" They realized that if the carrier wave and one of the side band frequencies could be eliminated, the use of the ether would in this way be increased threefold.

So the carrier wave, along with one of the side bands, was suppressed by a filter circuit. But the big task now was to actually receive the remaining wave side band, since the ordinary type of receiving set would not function under such a condition.

A Special Receiver

A receiver was produced with facilities for setting up separate locally sustained oscillations corresponding exactly in frequency to the carrier wave produced in the circuit at the transmitting station in order to create the side band wave, and then suppressed.

In the new receiving set, the interaction between the local oscillations and the side band wave, as received, produced a wave in the receiver corresponding exactly in form to the voice wave produced at the transmitting station.

We are now assured that with the 100-kilowatt transmitter operating at Rocky Point, it will be possible to receive the transatlantic signals in all parts of the country during the daytime.

How to Listen In

The best way to do this with present apparatus undoubtedly is with a regenerative receiver of the honeycomb type, using coils large enough to tune up to 6000 meters. For this purpose it will be necessary to use a 300-turn coil in the primary, a 400-turn coil in the secondary, and a 200-turn coil in the tickler. In the primary circuit the tuning condenser will have to be shunted across the honeycomb coil instead of being in series with the aerial.

This receiver in itself, however, will not be sufficient. It will be necessary to use an oscillator to provide the missing carrier wave frequency. It is here that the ingenuity of the fan himself will have to come into play, for he will have to discover for himself what that frequency is.

The oscillator can be constructed by placing an inductance in the grid and plate circuits of a hard vacuum tube. It will be necessary to place variable condensers in shunt across the coils, and the latter will have to be placed in an inductive relationship with each other. Tuning for the missing frequency will be done with the condensers. There will be a loose coupling between this oscillator and the main receiving set. The coils probably will duplicate the main primary and secondary.

POPULAR SCIENCE MONTHLY— Your Radio Textbook

FOR every man or woman, boy or girl, who owns a radio set, and for every other person who hopes to own one, POPULAR SCIENCE MONTHLY is indispensable.

In the pages of POPULAR SCIENCE MONTHLY every month you will find the latest developments in radio science that are the most important to YOU.

And you will always find a wealth of useful ideas that will add new pleasure to your radio set.

For example, this month, in addition to the tremendously important article by Jack Binns on this page, you will read:

How you can build your own dry cell vacuum tube set for \$20, on page 75.

How to assemble a three-stage loudspeaker set, on page 98.

What other radio fans throughout the country are asking. On page 123 our Radio Information Editor's clear, instructive answers to their six most pressing questions will help you solve your radio problems.

"side bands" they were trying to eliminate!

Without attempting to go into technicalities, we may describe the side bands of radio transmission as two secondary waves produced on each side of the modulated carrier wave by interaction between the voice wave and the carrier wave. Of these two side band waves, one varies in frequency from about 200 to 2000 cycles a second more than the carrier wave, while the other varies in frequency from 200 to 2000 cycles less than the carrier wave.

There are, therefore, three distinct waves sent out by a radio transmitting station—the modulated carrier wave, and two side band waves. Naturally, these waves cause

Flashlights Reveal Frog Monsters

Camera Hunters Find Strange Reptiles

EXTRAORDINARY flashlight photographs of strange barking and climbing frogs that inhabit the coral island of Santo Domingo in the West Indies form part of a valuable collection of reptilian life recently gathered for the American Museum of Natural History by Dr. and Mrs. G. Kingsley Noble.

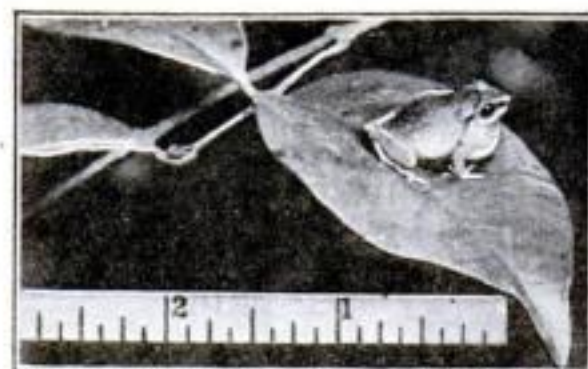
In one of the most unusual scientific expeditions ever undertaken, the explorers used automatic flashlights to photograph frogs in their native haunts. Months of preparatory labor were spent in perfecting this method of photography, which Doctor Noble first practised in obtaining pictures of frogs that infest New Jersey meadows.

In addition to their large collection of photographs, preserved specimens, and skins, Doctor and Mrs. Noble brought back nearly 40 living specimens of the largest lizards in the world, believed to be direct descendants of giant prehistoric reptiles; a huge tree frog; and an amazing species of frog that "barks like a dog and squeals like a pig."

The Santo Domingo horned lizard, which sometimes reaches a length of five feet, has an enor-



Believed to be a descendant of giant prehistoric reptiles, this strange horned lizard was discovered on Santo Domingo Island by Dr. and Mrs. G. Kingsley Noble, above



One of Doctor Noble's remarkable flashlight photographs of the Santo Domingo "barking frog." Note throat air chamber used by frog in producing huge noises

mous head, powerful jaws, a wide gaping mouth with deep indigo interior, a red tongue and little pink projections dotting its face. The entire upper body is armored with a crest of spines running from the back of the neck to the tail. It bears a close resemblance to certain dinosaurs.

Natives of Santo Domingo believe that weird barking sounds, which emanate from their forests at night, are caused by ghosts. Doctor Noble traced these noises to tree frogs. Even more curious are the

larger tree frogs that hatch from eggs into tadpoles, and reach their complete development while still in the water. They weigh a pound or more and perspire a strange milky liquid that causes blisters if it touches a person's skin, and fills the air with an intolerable odor.



The climbing tree frog, discovered by Doctor Noble and photographed by a magnesium flashlight, as shown at the right. The small circle shows location of frog in the foliage



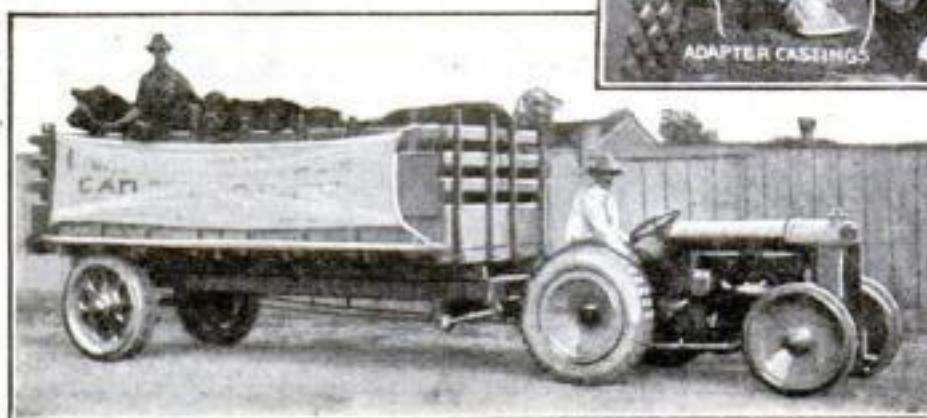
This preserved specimen of tree frog shows the octopuslike suckers on its feet, used in climbing trees or in attaching itself to stones in a swiftly flowing stream

Two-Wheeled Fordson Trailer Clamps to Rear Axle

ATWO wheeled trailer of the dead axle type, that will follow in the tracks of the towing vehicle, has been designed for direct attachment to a Fordson tractor through adapter castings that clamp solidly to grooves in the rear axle housing of the tractor, immediately inside of the wheels.

A wishbone shaped frame that acts as a swinging tongue, is pivoted to the rigid rectangular frame in such a way as to allow the tractor to turn sharply without turning the main frame of the trailer until this frame reaches the point where the tractor started to make the turn. This facilitates the movement of loads in cramped places.

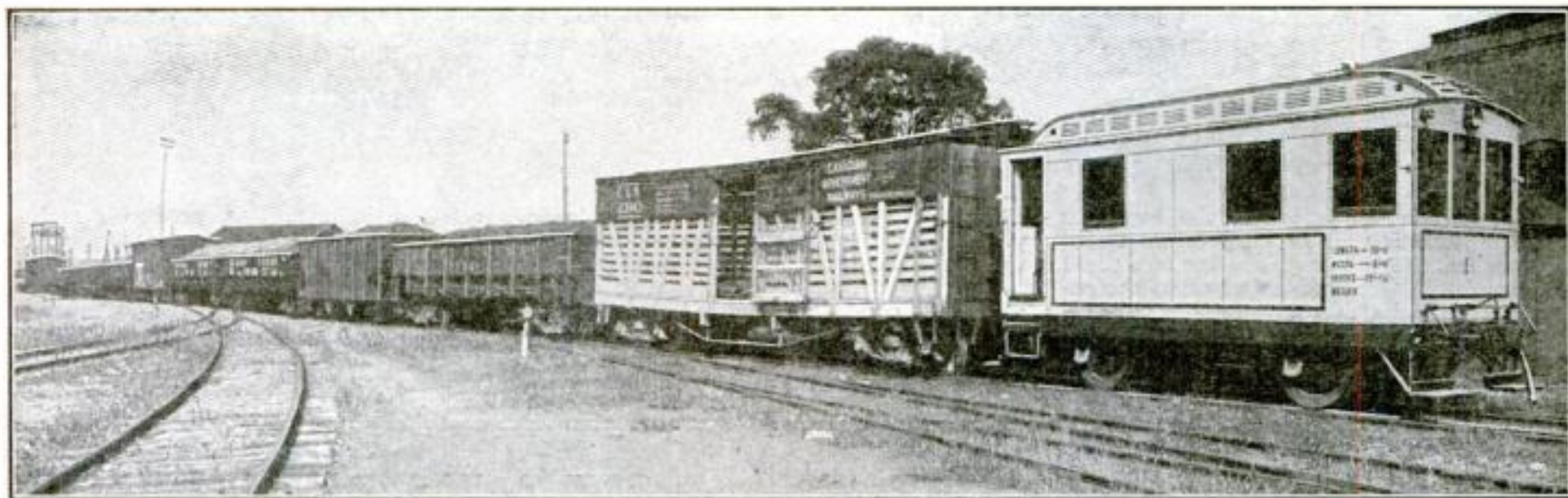
A drum on the axle housing of the tractor enables the driver to snub out of holes by attaching a 100-foot cable to a dead-man and winding the other end around the drum. The tractor can thus wind the cable and haul itself, by its own motive power, out of difficult places.



Upper left: Frame of the two-wheeled trailer, showing pivoted members. At left: The complete tractor trailer. Above: Rear axle of tractor, showing adapter castings and drum for snubbing out of mud

Oil Transmission Drives Gearless Car

Extraordinary Invention May Revolutionize Speed Control



Hauling cars weighing 645 tons, this gasoline locomotive, with 150-horsepower engine, has applied the oil drive transmission system with such success as to promise gearless transmission for automobiles. Engine and transmission give a maximum speed of 12 miles an hour

WILL clashing gears and slipping clutches—the bane of automobile drivers—soon become things of the past?

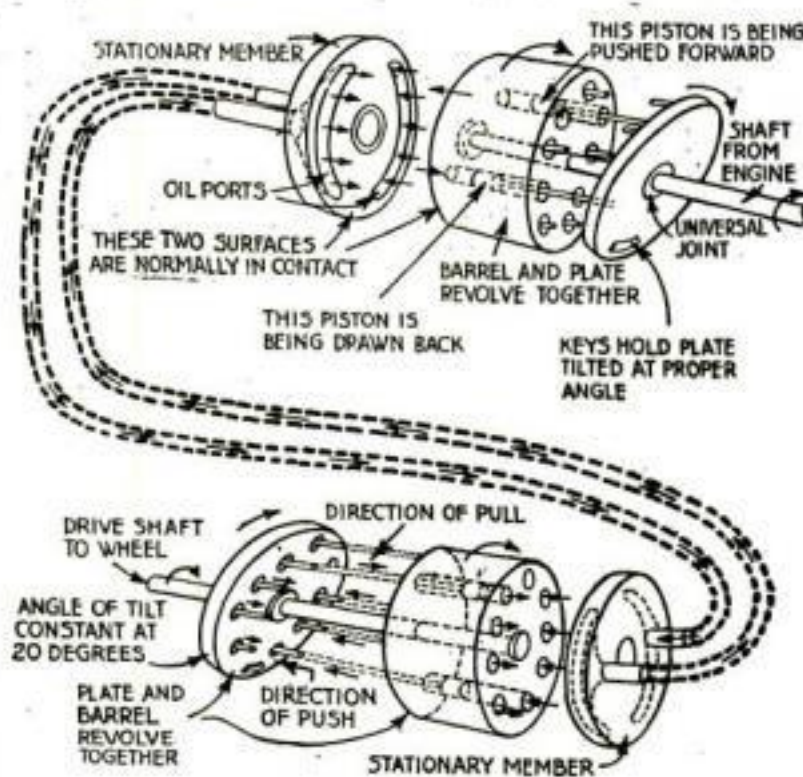
The promise that gearless transmission may soon be applied successfully to pleasure cars and motor trucks is offered in the recent effective application of an ingenious oil pressure drive system to a gasoline switching locomotive—an achievement accomplished by John Robson, chief engineer of the Universal Engineering Corporation of Montreal, Can.

Because it provides a practical method of eliminating gearbox, clutch, countershaft, and possibly the differential in automobiles, the invention has been hailed by engineers of the company as a revolutionary development in speed transmission.

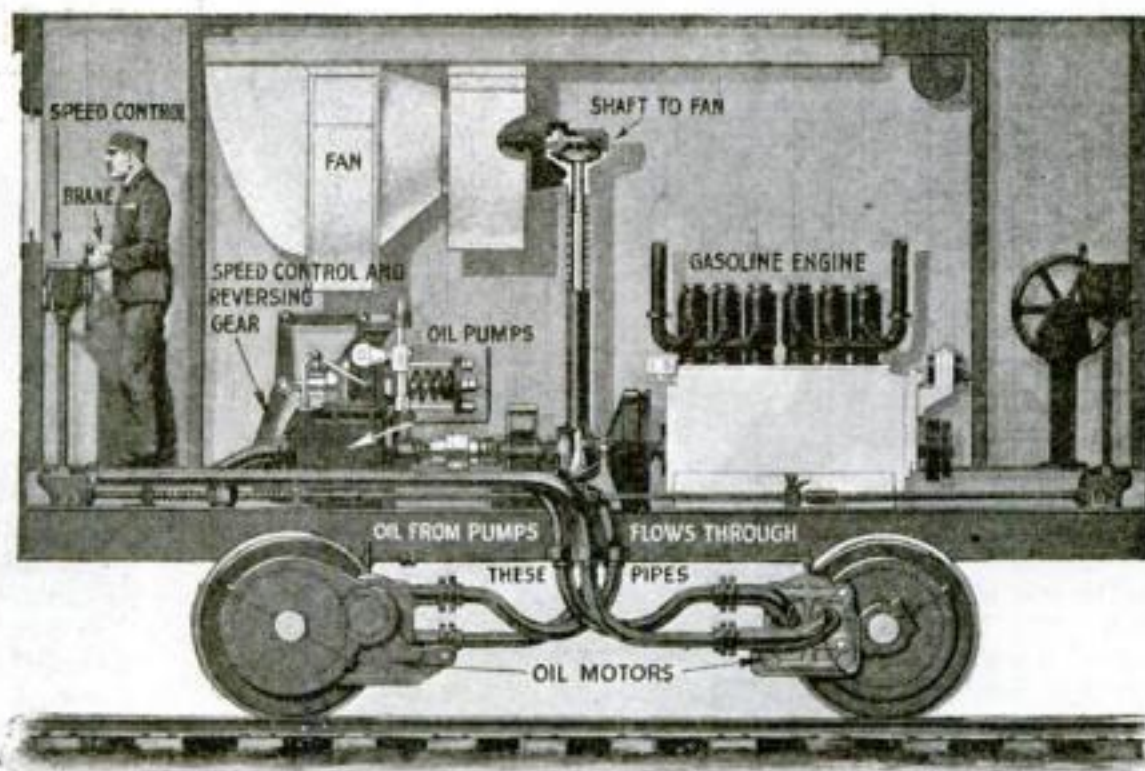
Without gears, how is the power of the rotary gasoline engine transmitted to the wheels of the car? Simply by reciprocating motion of oil under pressure—an oil flow created by an oil pump unit driven by the engine, and delivered through pipes to a motor unit that drives the wheels.

These two transmission units—the oil pumping unit and the driving unit to which the oil is delivered under pressure—are similar in form, yet opposite in method of action. Both operate on the same principle, which is this:

If a balanced disk is mounted on a pin or shaft in such a manner that it tilts at an angle with that shaft, any force applied on either side of the disk will cause the disk to rotate—provided friction is sufficiently reduced. For example, an ordinary bicycle wheel held at an angle with the horizontal



This diagram shows operation of oil pressure transmission as applied in switching locomotive below. At top is the oil pumping unit actuated by engine drive-shaft, and producing flow of oil that operates the wheel driving unit



Diagrammatic cross section view of gasoline switching engine pictured at top of page, showing arrangement of oil transmission system. Note that the operator obtains any speed desired, or reverse, simply by moving a lever

will rotate until the valve has reached the lowest position, the weight of the valve corresponding to the force applied to the side of the disk mentioned above.

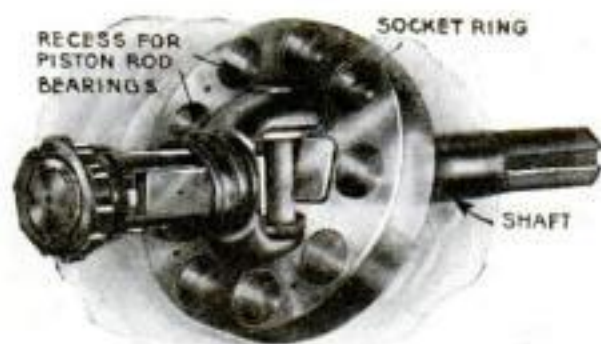
Similarly the rotation of the disk will exert a force parallel with the axis of rotation.

Just such a revolving tilted disk is the actuating part of the oil pumping transmission unit. It is called the "socket ring" because it contains a circular series of nine sockets. This socket ring is attached to the engine drive shaft through a universal joint. Inclosed in the same case is a barrel of nine cylinders through which move nine pistons actuated by connecting rods. These rods are fastened into the ring sockets by means of balls, producing a universal joint arrangement. Thus, as the engine shaft turns the socket ring, the pistons are moved back and forth in their cylinders.

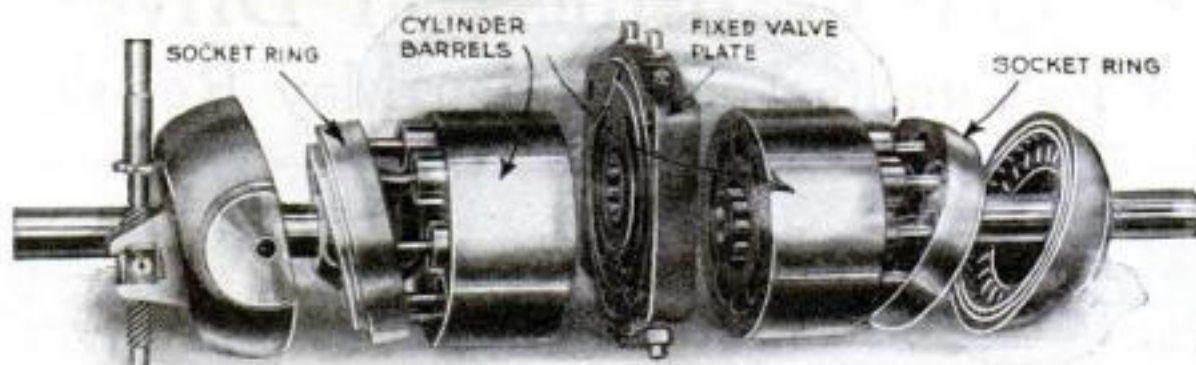
At the end of the cylinder barrel opposite the socket ring is a circular stationary member or valve plate containing portholes through which oil is forced into and drawn from the transmission pipes by the action of the pistons.

The second, or wheel driving unit, is similar in construction, except that the order of operation is reversed and that the socket ring remains at a constant 20-degree angle of tilt with the vertical.

In operation, the entire system, including the two units and connecting pipe, are filled with oil. As the drive-shaft of the engine revolves, the motion of the tilted socket ring of the oil pumping unit causes four of the pistons to push forward and four to pull back, while a ninth piston is at, or near, dead center. The result-



ACTING as a pump, the ingenious driving unit of oil pressure transmission, shown above, consists of a tilted disk, or socket ring, attached to the engine drive-shaft through a universal joint. As the ring rotates with the shaft, nine pistons with rods bearing into the sockets move back and forth, producing flow of



oil under pressure through transmission pipes. Speed is governed by the angle at which the ring is tilted.

The two transmission units with similar parts, yet opposite in action, are shown in illustration at right. The unit at the left is the pump in which rotation of the engine drive-shaft, acting through tilted socket ring,

sets pistons in motion, producing reciprocating motion of oil stream. At right is the wheel driving unit, or motor, in which the oil, passing through ports in a fixed valve plate, is taken up by pistons bearing against a tilted socket ring fixed on the wheel drive-shaft, causing the ring and shaft to rotate and thus turning the wheels

ing pressure movement of oil down one pipe and back through the second pipe, passing through the portholes of the second, or wheel driving unit, is taken up by the pistons in this unit and converted into rotating motion of the second socket ring. Thus, on one side of the wheel driving socket ring there is a series of pushes, while on the other side is a series of pulls, resulting in a tendency to turn the disk. And since the cylinder barrel moves with the socket ring, the pushing pistons become pulling pistons as the ring revolves, thus insuring continuous rotation of the wheel drive-shaft to which the socket ring and cylinder barrel are attached.

Obviously, the amount of tilt of the

socket ring in the pumping unit governs the speed at which the wheel drive-shaft turns; for the greater the tilt of the ring, the greater will be the push and pull exerted in the oil by the pistons. Or, to put it differently, if the socket ring were not tilted at all, the pistons would not move back and forth. Likewise, if the tilt of the socket ring is reversed, the flow of oil through the pipes is reversed correspondingly. Consequently the rotation of the wheel driving socket ring is also reversed, imparting a backward motion to the wheels.

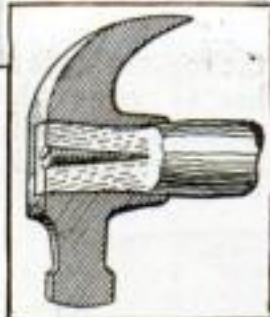
Thus the driver of the car may start the machine from rest, obtain any speed desired up to the limit, without steps or gradations or reverse, simply by moving a lever that

regulates the tilt of the first socket ring. Any speed can be attained without varying the speed or direction of rotation of the engine. No clutch pedal or gearshift is required.

The constant flow of oil through all the working parts keeps the engine and transmission thoroughly lubricated. Since no parts are brought into violent contact, as is the case with the present gearshifts, the life of the transmission system should be greatly lengthened, the designers believe. Stripping of gears would be impossible. Even if the tilting lever should be moved wrongly, the oil would prevent immediate reversal of power. The car would simply stop gradually, then start reversing.



To tighten the hammer head, this conical screw is driven into the handle by a screwdriver and serves as a wedge



Headless Screw Tightens Loose Hammer Head

A READY means of tightening the handle of a hammer, hatchet, ax, sledge, or other tool of the impact type is provided in a take-up wedge perfected by Fayette R. Plumb, of Philadelphia, Pa., who apparently has solved a century-old problem of invention.

The new wedge consists of a conical headless screw that is inserted in a hole at the top of the handle. The hole is drilled somewhat deeper than the length of the screw and is reamed to fit it. The larger end of the screw is provided with a slot to receive a screwdriver and in this way the wedge is driven until it is flush with the end of the handle. Should the hammer loosen, it is necessary merely to drive the screw in farther, spreading the wood against the sides of the eye and thereby tightening the handle.

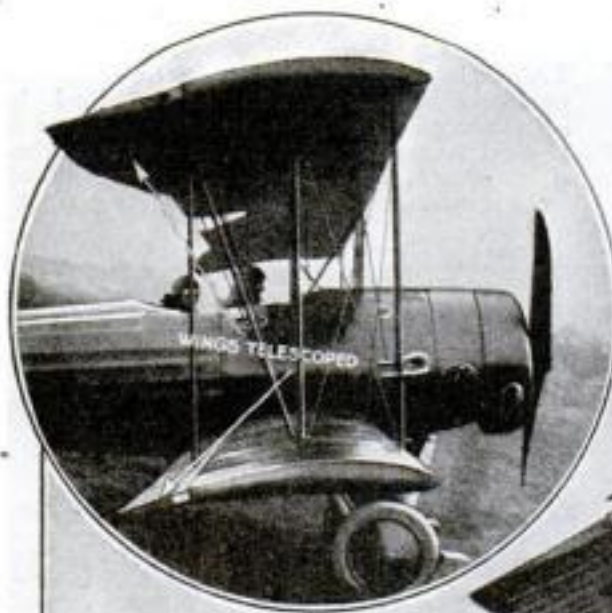
Telescoping Wings "Brake" Airplane

ONE of the most difficult problems of flying—that of reducing the speed of a high powered airplane to a minimum without slowing down the engine—has been solved to some extent by a Frenchman, M. Bille, who has invented an airplane in which

the wing surface can be mechanically increased, thus cutting down the speed of the machine.

Early inventions for varying the size of wings in flight lacked wing rigidity necessary to safe flying. Bille's invention overcomes this handicap by means of two pairs of extension wings that telescope snugly into the main wings of the plane, so that they can be extended or taken in at will during flight.

At a recent demonstration of the plane, Maneyrol, the French record making aviator, flew 100 miles an hour, then slowed down to 35 miles, and finally to 12 miles, simply by extending the wings. This was done in six seconds.



To reduce speed in flight, the telescoping wings are extended, as shown above, increasing wind resistance. Inset shows the Bille plane with wings telescoped

How Far Would You Trust These Men?

Each One of These Photographs Has a History—Can You Read Character Well Enough to Guess It?



NEW light on the science of reading character and the science of detecting criminals has been thrown by a novel photographic experiment recently made with the cooperation of the Police Department of New York City. Each face on this page is a combination, or composite, of eight or 10 photographs taken at random from the famous rogues' gallery of New York police headquarters. Each face is a composite of a specific type of criminal.

Note how different from each other these portraits are. Then see how good a judge of faces you may be. Guess what you would suspect each man to be guilty of. Next, refer to the inside column of the following page and read which class each wrongdoer actually belongs to. Burglar, forger, murderer, highwayman, and counterfeiter are among the group. Can you spot any of them before you refer to the "key" diagram?

This test may help you answer in your own mind the great question whether criminals are born, or are made by circumstance, hard luck, and evil associates. One theory—that of the noted Italian criminologist, Lombroso, who set the world talk-

(Continued on page 48)



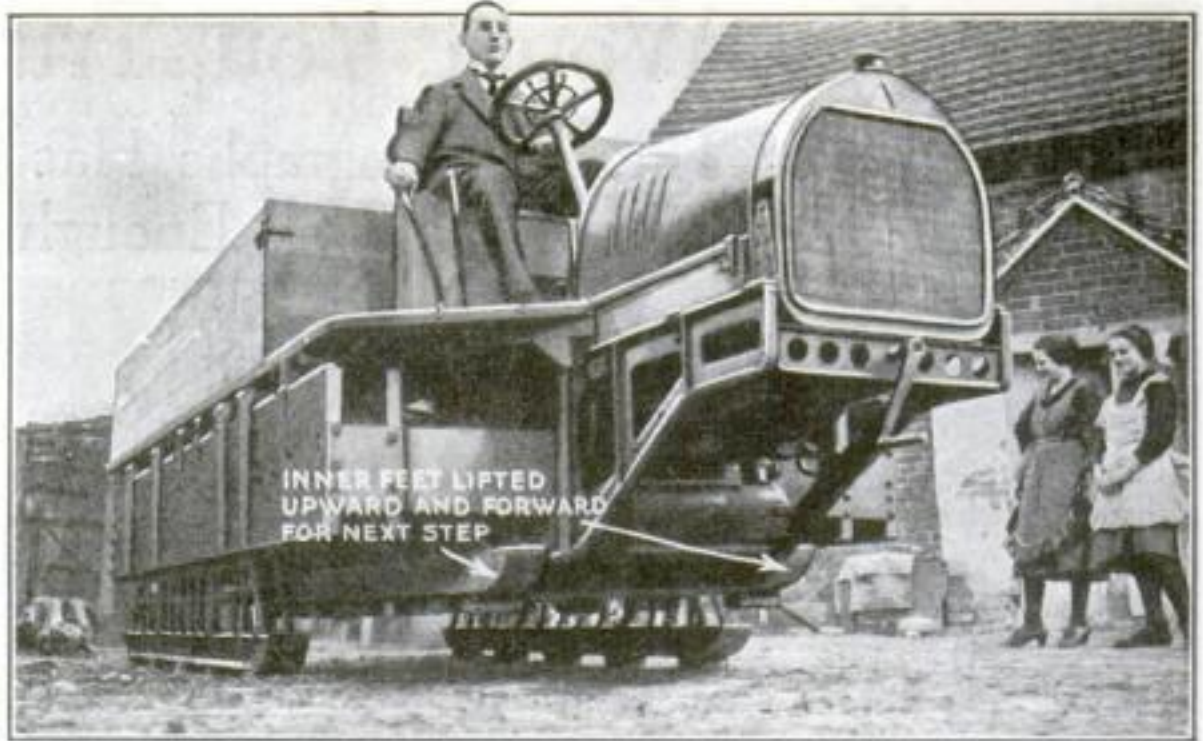
Spiral Wire Holds Tennis Balls to Racket

DESIGNED for players who do not use a racket case with pockets or for those who use no case at all, a new tennis ball holder has recently been invented by Thomas Beets, of Independence, Mo., and consists of a single spiral brass wire that holds two balls firmly against the racket, one ball on each side.

When not in use, the wire is slipped off the racket and hung on the net.



How spiral wire holds tennis balls tightly to racket



Wheel-Less Truck Walks on Metal "Feet"

A NEW wheel-less motor truck that actually walks on metal feet is the invention of a German manufacturer. The "walking" truck is a development of the tank idea and is equipped with two sets of runners, each of which has five heavy metal "feet" that sink into heavy or muddy ground and thus gain traction.

While one set of runners is being raised and moved forward, the weight of the truck rests on the other set. As the forward moving set gains a footing, it pulls the load forward, while the other set repeats the motion—similar to the walking motion of a human being or an animal, conveying heavy loads on comparatively little power.

Maple Sap Piped to Sugar Camps

IN THE sugar maple groves of the northern United States and Canada, modern scientific methods have come not only to save time and labor, but also to make the processes of manufacturing maple syrup and sugar more sanitary. Where once the maple sap was gathered by hand in open wooden buckets, today many of the groves are equipped with pipe lines direct from the trees to the evaporating pans in which the syrup is made.

Usually the "sugar orchards" are located on hillsides which, during the season when the sweet sap flows, are covered deeply with snow, offering difficult footing for

men and horses. Formerly each sap gatherer was supplied with pails, hung from a yoke slung across his shoulders, and into these pails he poured the sap that had accumulated in wooden buckets hung on the trees beneath the taps.

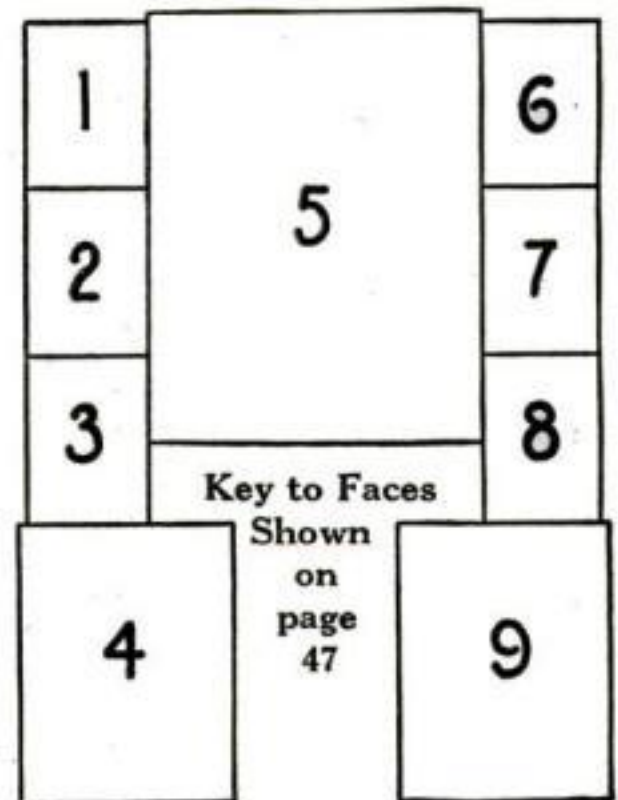
When filled, the pails were emptied into a tank attached to a sled, which was hauled down the hillside to the "sap house," where the syrup was made. The tremendous amount of hand labor required by this method may be realized from the fact that a barrel of sap makes only about a gallon of maple syrup.

Adopting improved methods, the more progressive farmers today have equipped their orchards with networks of piping. Workmen pass from tree to tree, lift the filled buckets from the spouts where the trees are tapped, and pour the sap into small receptacles opening at intervals into the pipe lines.



Above: The new way. From the maple grove, the sap accumulating in buckets on the trees is poured into pipe lines that carry it by gravity to the sugar camp shown in the right background

At right: The old way. From open wooden buckets hung beneath the spouts on the trees, the sap was collected in pails hung from a yoke slung across the shoulders of the sap gatherer



1. Swindler (grand larceny). 2. Burglar (second-story man). 3. Firebug. 4. Forger. 5. Burglar (safe-cracker). 6. Pickpocket. 7. Murderer. 8. Robber. 9. Counterfeiter

(Continued from page 47)

ing a few years ago—is that criminals are born—that physically, there is a distinct criminal type. The majority of criminologists deny this.

The scientist will tell you, moreover, that the composite photo is not always to be trusted. But the composite pictures on page 47 certainly seem to indicate distinct types of evildoers, and what you read in each face corresponds to characteristics attributed to the various classes both by the celebrated Lombroso and by New York detectives who claim to be able to spot a criminal by his features.

Note, for instance, the determined energy and intelligence in the safe-burglar's face; the apparent degeneracy in the murderer's, and the seemingly refined traits of the counterfeiter.

How Flowers Turn Their Faces to Follow the Sun



California poppies photographed at 10:30 a.m., turning their blossoms toward the east



The same poppies at high noon. The blossoms have opened, face upward



At 3:30 p.m. Craning their necks toward the west, and closing their petals for the day



Handsome Traffic Tower for Fifth Avenue Unveiled

IN ORDER that New York City's traffic towers may be artistically attractive, the Fifth Avenue Association has presented to the city seven artistic bronze towers, to be erected along the famous avenue.

The first of these, recently unveiled at Forty-Second Street, contains a bronze bell weighing 350 pounds that tolls out the hours to the hurrying crowds below.

All towers along the avenue operate simultaneously, permitting traffic to cross the street for two minutes, then allowing a five-minute interval for travel along the avenue. Colored lights in the top of the tower indicate to drivers and pedestrians the direction of travel at any instant.

The World's Largest Automatic Sprayer

AN ENTIRELY new method of irrigating large tracts of land has been developed recently in France by E. Rolland, who has invented the largest automatic sprayer in the world. Mounted on wheels that run on rails along a steel bridgelike span, the huge sprayer automatically distributes the water evenly over a given surface as it moves back and forth.

In the first demonstration of his invention, Rolland has constructed across the center of a large truck garden plot, a steel truss framework, the top of which is approximately 12 feet from the ground level. This framework, supported at intervals by piles resting in concrete blocks, serves to carry rails on which the apparatus runs. The steel structure also supports a trough or conduit that carries the water for spraying, as well as the water turbine that supplies power to run the apparatus.

The spraying apparatus itself consists of a long steel frame suspended from a four-wheeled truck that runs on the rails at the top of the truss framework. At each side of the sprayer frame, which is hung at right

angles to the truss, are long conduits from which, at various intervals, the water spouts from nozzles. The truck carries this apparatus at an even speed, automatically reversing and returning when the end of the track is reached.

The truck is operated by a water turbine stationed at one end of the frame truss-work. The power is transmitted through pulleys arranged so that either forward or reverse motion is obtained. As the sprayer proceeds along the track, it draws water from the trough above it by means of a siphon. Stopcocks regulate the flow, and the turbine is operated by the force of the water.

This method is said to be superior to ditch irrigation, requiring less manual labor and distributing the water more evenly.



Above is the steel truss on which runs the huge automatic sprayer seen in the distance. Note turbine connected with water supply in the foreground. Inset shows how sprayer is suspended from trolley running on rails

Tiny Thunderbolts Help Mushrooms Grow



Above is the interior of the "mushroom ranch," where artificial growing methods produce the prized fungi. The mushroom "hat" shown at right weighs seven pounds and is 53 inches in circumference

MINIATURE thunderstorms, artificial fogs, and a drumming kind of "jazz music" are among the artificial means employed in a new scientific method of growing mushrooms, developed by A. G. Hupfel, Jr., of New York City. With such a combination of stimulants, Hupfel claims he can grow mushrooms above ground as well as in the cellars or caves where they are usually raised.

Since mushrooms are parasites, lacking the chlorophyll or green substance of other plants, they cannot assimilate air and water necessary for growth, but must depend on other plants to manufacture their organic food. For this reason they require especially prepared beds containing organic food at the correct temperature.

Hupfel's mushroom farm is located in a dismantled New York brewery. Water for the beds is supplied by artificial fog produced by passing steam from the old brewery boiler through refrigerating apparatus. Fog is created this way about twice a week.

Breathing, like eating, is difficult for



mushrooms. To help them breathe, Hupfel has installed static machines that produce sparks of electricity, releasing oxygen from the air in the same manner that lightning flashes do. The static generators, he says, have a decided effect on the crops, explaining why wild mushrooms grow best during thunderstorms.

The "jazz music" process of stimulating mushroom growth remains a secret with its inventor. It consists of a mechanism that produces a constant drumming noise to which the plants are said to respond. The constant agitation is supposed to increase the formation of plant cells and consequently the amount of organic matter.

THE Editor will be glad to supply, wherever possible, the names and addresses of manufacturers of devices mentioned in this issue.



Courtesy Engineering News-Record

Net Safeguards Riveters

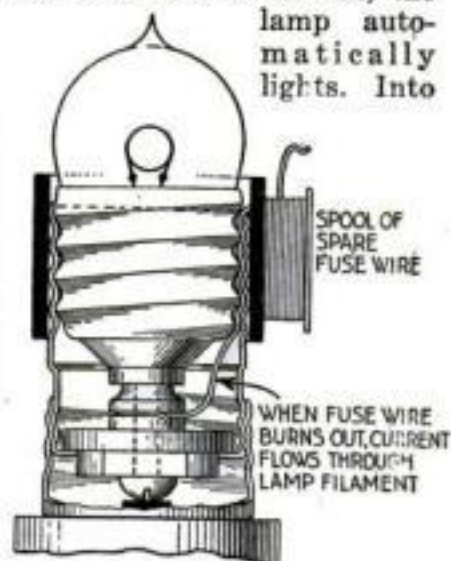
AS A protection for riveters engaged in erecting a steel standpipe at Carthage, N. Y., a "circus net" safety device attached to the brackets that support the scaffolding, has been developed by C. W. Penrod, foreman of the Chicago Bridge and Iron Works.

Should a workman slip from the narrow scaffold and fall, the net would catch him and save him from certain death.

Pilot Light Flashes if Fuse Burns Out

THE exasperating labor of testing electric light fuse plugs in a large panel to determine which fuse has burned out has been eliminated by the invention of a renewable plug with small pilot lamp attached. When the fuse burns out, the lamp automatically lights. Into

When this plug is in use, the pilot light is short circuited by the fuse; but when the fuse burns out, electric current flows through the lamp filament



a plug of the ordinary type the inventor, C. F. P. Carrier, of Philadelphia, Pa., has inserted a socket that holds the pilot lamp.

Ordinarily current passes from the center contact through the fuse to the sleeve, and

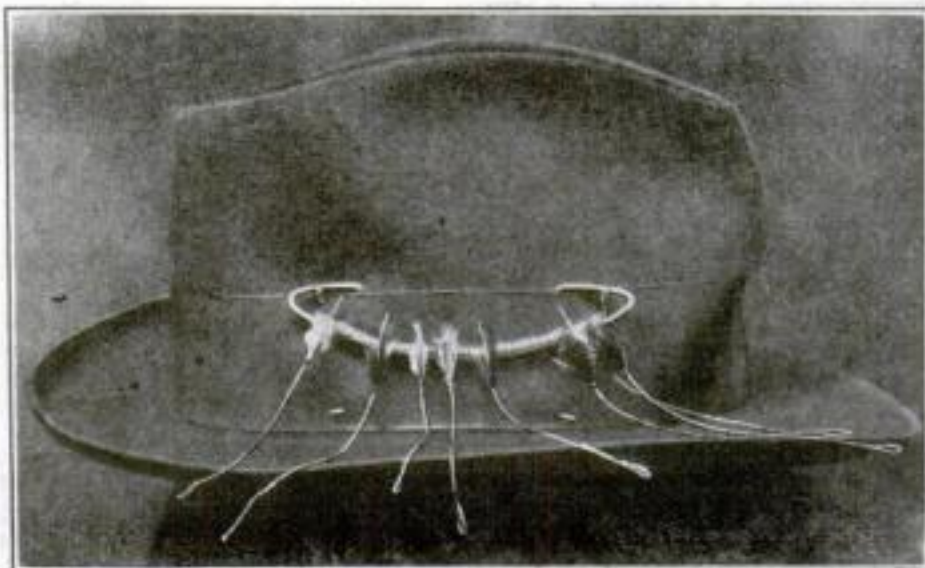


the lamp remains unlighted because the fuse short circuits the filament. When, however, the fuse is broken, this short circuit is removed and the current passes through the lamp filament.

When the fuse burns out, the lamp is removed, and a short length of fuse, unwound from a spool of spare fuse wire at the side of the plug, is strung from a knob in the bottom of the plug upward into the lamp socket.

How to Carry Fishhooks on Your Hat

MOST boys and fishermen who have had sad experiences with fishhooks will welcome an ingenious hook holder, consisting of a spring coiled about a wire that can be attached to an old felt hat. The hooks are caught over this spring.



The Jumping Balloon—Thrilling New Sky Sport



HOW would you like to own your own hand-power jitney balloon—to spend your Saturday afternoons joy-riding in the sky, up a thousand feet or so, swinging beneath the round belly of a small gas-filled bag and traveling anywhere you can induce the playful breezes to take you?

You sit in a suspender-like harness slung from ropes. In your hands you grasp a stout pulley rope. You give a strenuous tug on the rope—just like pulling an old fashioned elevator cable. A small horizontal propeller whirs just above your head—and up you go, jumping into the sky 100 feet at a jump!

You Need Not Be an Expert

Here's a new sport that you can't beat anywhere for thrills and for the exhilarating exercise of skill and muscle, if you take the word of those who have tried it. The hand-propelled "jumping balloon" is the recent invention of M. Q. Corbett, W. E. Hoffman, and C. F. Adams, of the army "lighter than air" squad at McCook Field, Dayton, Ohio. And the best part of it is that you don't have to be an expert to sail it. A schoolboy or even a sober business man whose feet have never left earth can safely handle the jumping sky jitney.

Why? Because you can control the ups and downs of the gas-filled bag simply by pulling a rope that whirls a propeller. You don't need a load of ballast to throw off when you want to ascend, and you don't need to let gas out of the bag when you want to come down. All you need is healthy muscle power to whirl a propeller fast enough to produce a five-pound thrust, up or down, equivalent to five pounds of ballast or a lifting force of 70 cubic feet of gas.

Where Skill Adds to Sport

But you may acquire skill in judging air currents, and making use of them to travel where you want to go. And that is where the chief sport comes in—a sport that, balloonists tell us, is more fascinating than any other sport in the world.

The new jumping balloon has held an altitude of 1000 feet for 40 minutes and has landed from 3000 feet without the use of ballast. It has made a flight of six hours' duration, with five landings and five changes of pilots, two of whom never before handled a balloon, and it has jumped as high as 150 feet in one jump.

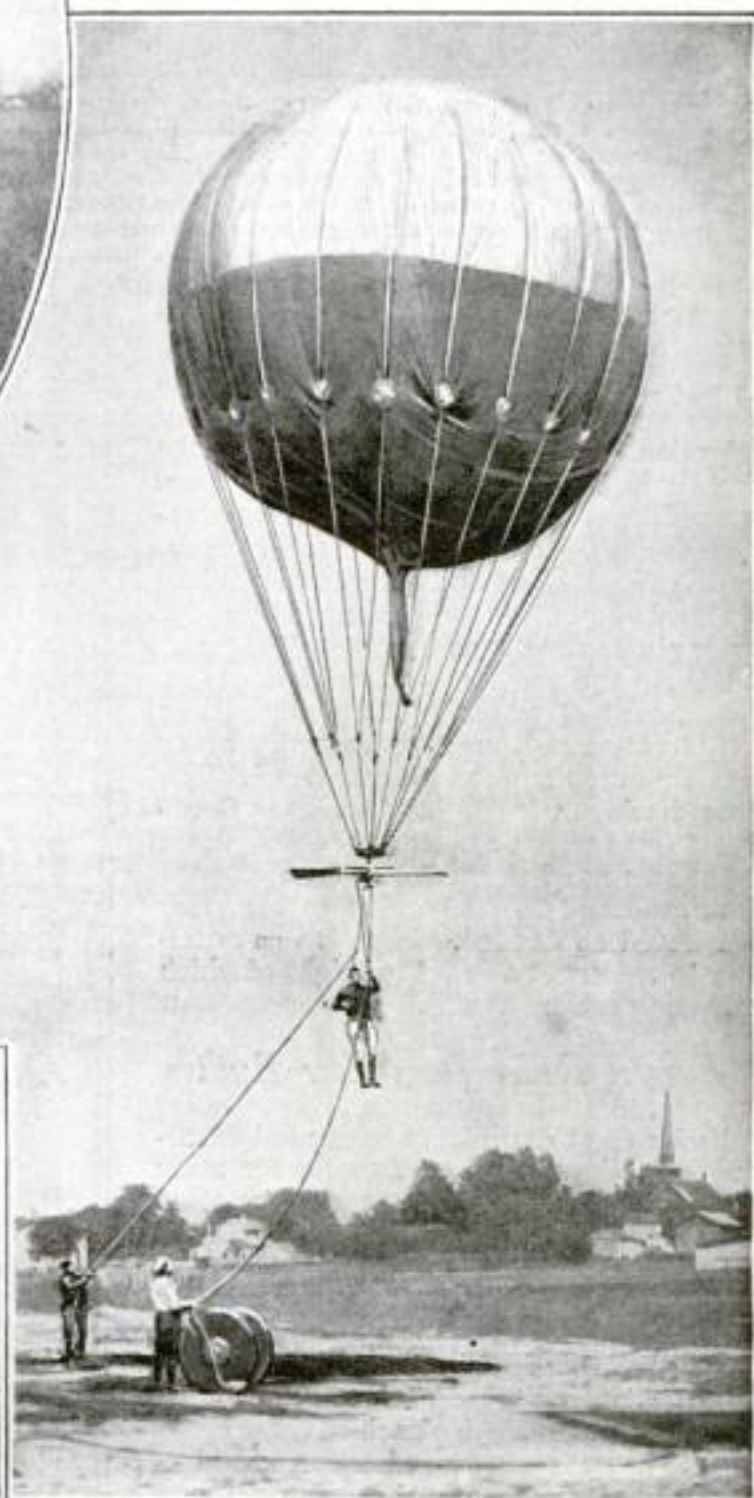


Horizontal propeller and pilot's harness are slung from the gas bag, as shown above. By hauling on a pulley rope, the pilot whirls the propeller, producing an up or down thrust that takes the place of ballast or gas valve as needed.

Weighing only 50 pounds the entire outfit can be carried in a bundle small enough to pile into an automobile.

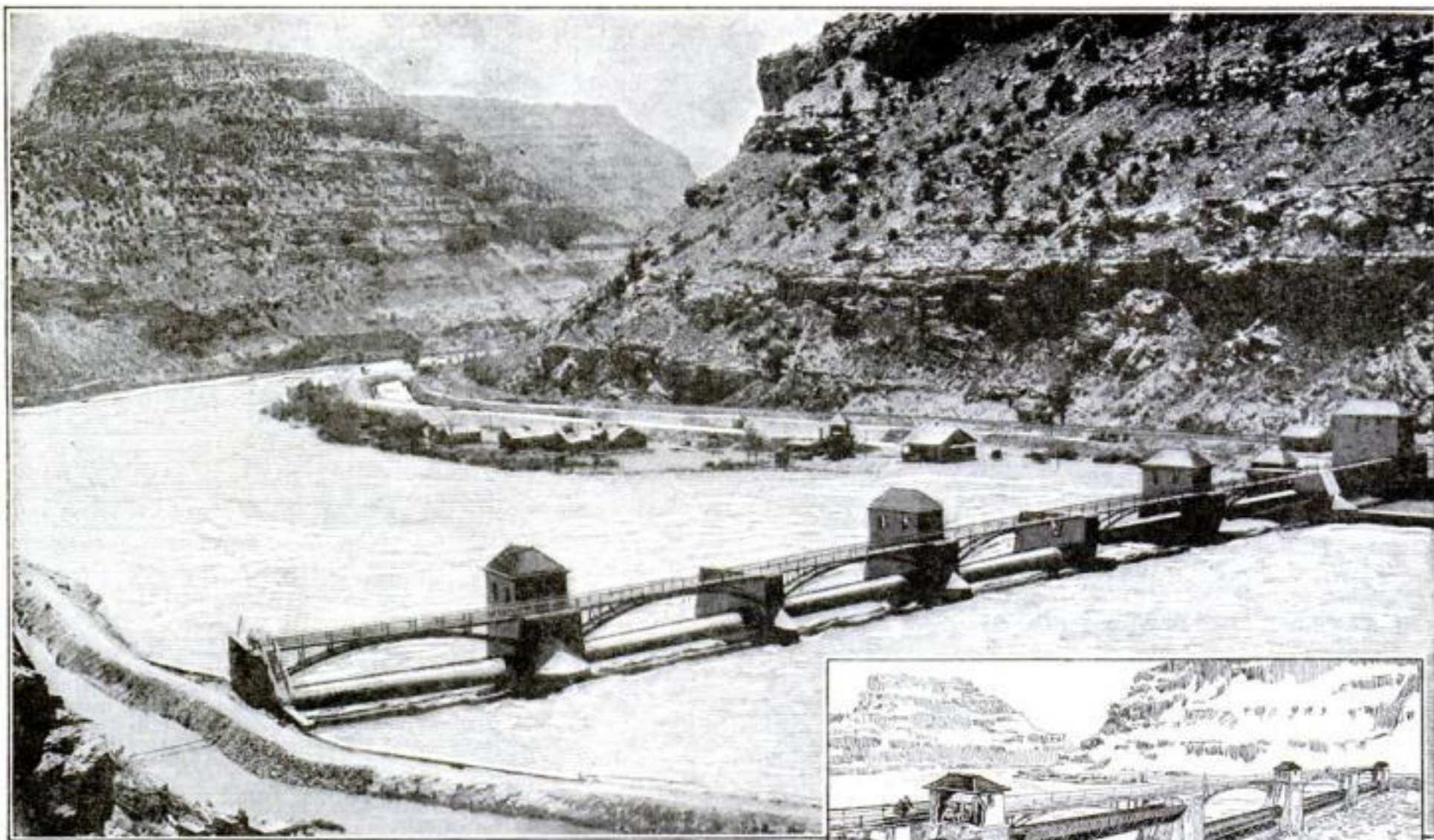


How a party of jumping balloonists can sail off together on a sky excursion. Such an arrangement, in fact, was the chief purpose of the inventors—to be used in training students of ballooning by roping their ships to an instructor's craft.



Up she goes! The gas-filled bag of the jumping balloon, of single-ply rubberized fabric, is capable of lifting a 180-pound man, as proved in this actual test at the McCook Aviation Field, Dayton, Ohio, where the invention had its first tryout.

Crest of 500-Foot Dam Lifted Clear of Floods



The world's largest roller crest dam, on the Grand Valley irrigation project, Colo., is shown above with pipe-like crests lowered to raise the overflow level of impounded waters more than 10 feet, and thus provide a reservoir sufficient to supply the irrigation canal during low water periods on the Grand River. The illustration at the right shows how the roller crests are raised at floodtime, permitting unhindered passage of high waters.

TO MEET unusual flood conditions in impounding the waters of the Grand River, Colo., United States engineers in charge of the Grand Valley irrigation project have constructed the world's largest roller crest dam—a huge bridge-like structure 546 feet long, supporting seven pipe-like sections, or roller crests, which can be raised and lowered to regulate the level of overflow, and thus the height of water above the dam.

During the greater portion of the year, the amount of water in the Grand River bed is very small and consequently every possible amount must be conserved. The river, however, is subject to violent floods and if there were no means of cutting down the maximum height of the dam at such times, railroad tracks parallel to the river bed would be flooded. Thus it was necessary to construct a dam the height of which could be changed at will.

Largest Roller Dam Ever Built

Roller crest dams have been used extensively in Germany and Austria for some time and two others have been constructed in this country, but none is of the magnitude of the one built in Colorado. The dam proper consists of a concrete weir resting on gravel. Supported on piers above this dam are the roller crests—hollow steel cylinders 74 feet nine inches long and seven feet $1\frac{3}{4}$ inches in diameter. To each of these cylinders is attached a curved apron shield of steel which, when the crest is down, rests on the sill of the dam, forming a seal.

Ends of the roller crests project into recesses in the piers and roll on smooth tracks embedded in these recesses at an angle of 20 degrees with the vertical. Around each end

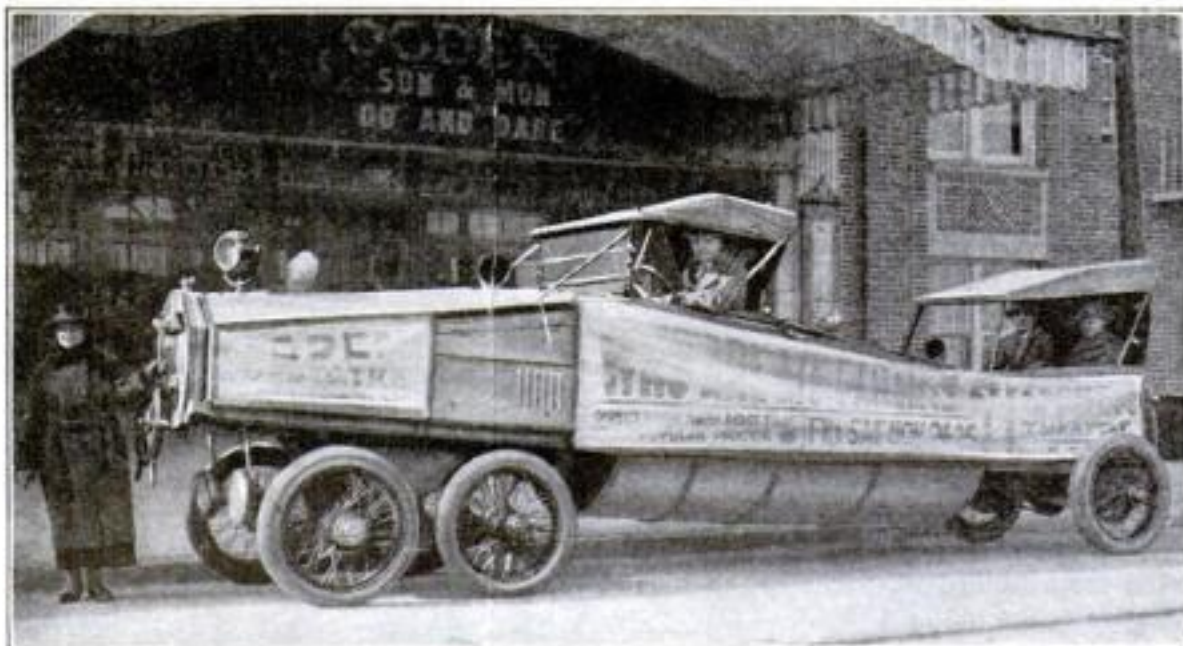
of the rollers is a toothed rim engaging a toothed rack fixed parallel to the track. The rollers are raised or lowered by means of a chain, one end of which is fastened about the roller, partly encircling it. The other end is wound about a drum in the hoist house surmounting the pier.

When the rollers are lowered, with the curved shield extension resting on the concrete dam, the height of the dam is increased 10 feet three inches, holding back sufficient water in the dry season to furnish a steady flow through the irrigation canal.

With the rollers raised, and the height of the dam decreased, flood waters pass under the rollers, without endangering the dam or the railroad tracks that run at the side of the stream.

In order to construct a cofferdam, a pile bridge was needed. Overriding many difficulties, the superintendent of construction succeeded in getting the bridge built. A heavy flood came down almost as soon as the bridge was built, but fortunately it withstood the strain.

Elongated Auto Is Moving Signboard



Designed to attract attention to advertisements on its sides, this elongated, six-wheeled auto is being operated profitably by a woman in Jersey City, N. J.

New Crankless Auto Engine Saves Power and Wear

REPLACING the usual automobile crankshaft with a floating disk, or "wobble plate," against which the pistons drive with direct horizontal motion, a new crankless engine recently tested by the Massachusetts Institute of Technology, has been given a rating of 75 per cent efficiency—15 per cent higher than the most efficient gasoline engine of the present day.

A Revolutionary Power Plant

In operation, the engine has actually driven an automobile more than 5000 miles without requiring attention.

Representing three years' work by Dr. E. H. Armstrong, C. W. Clements, and three other inventors, and the expenditure of more than a quarter of a million dollars, the invention is said to represent a revolutionary departure in power plant design. These men claim for their engine:

Greater power with far less fuel consumption.

The elimination of 150 parts now used in the average automobile engine.

Extremely low cost of production and low upkeep cost.

In the ordinary gasoline engine, the piston connecting rod at its full downward thrust against the crankshaft, is approximately 37 degrees out of line, creating a tremendous side thrust on the cylinder walls, traveling a wasteful distance, and causing a loss of power. By substituting the floating plate, the power thrust of the pistons is delivered with a direct, horizontal motion, and transmitted directly to circular plates fixed to the drive-shaft.

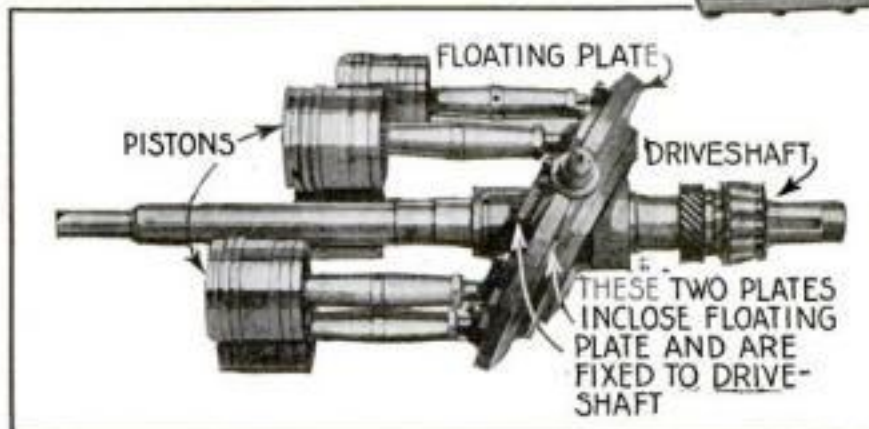
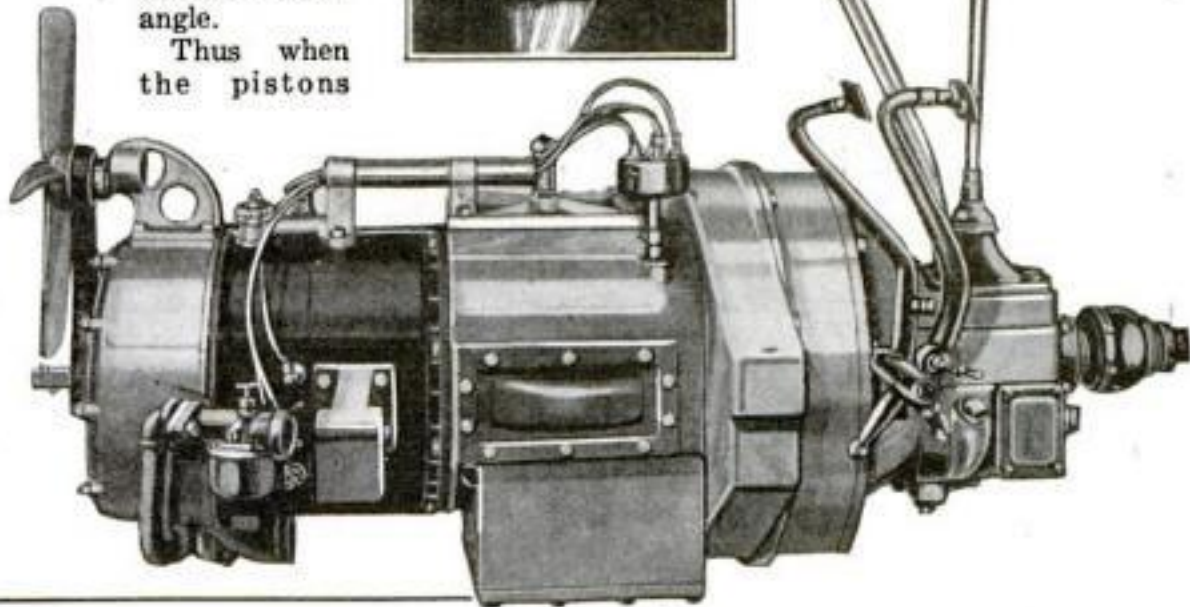
In the engine five cylinders surround a stationary shaft to which they are parallel. From these cylinders five connecting rods extend to a circular floating plate with which they are connected by ball-and-socket joints. The center

of this plate is attached to the shaft through a ball-and-socket joint, so that while it cannot rotate, it can tilt back and forth on its axis. Flush against each side of this plate is a stationary plate of similar form fastened to the drive-shaft at a fixed angle.

Thus when the pistons



After three years of experiment, Dr. E. H. Armstrong, inventor of the novel crankless engine shown below, has produced a revolutionary automobile power plant



The above diagram shows how Doctor Armstrong has replaced the usual crankshaft with a tilted floating plate against which five pistons exert direct, horizontal thrusts. Oscillations of this plate rotate two adjacent tilted plates fixed to the drive-shaft

push against the outer edges of the floating plate, the thrust causes the two stationary plates to rotate and turn the drive-shaft. The five pistons exert their push in rotation, thus producing a steady flow of power on the drive-shaft and distributing the wear over the entire surface of each ball and socket.

The inventors believe the engine is admirably suited for use in military airplanes because of the fact that the straight shaft could be made hollow, rifled like a gun barrel, and cooled by the motor cooling system.

Surgeons Save Life of Huge Python

BY PERFORMING two operations within two weeks—probably the first attempt to apply surgery on such a scale to the treatment of reptiles—surgeons recently saved the life of a valuable python transported from India to Long Beach, Calif.

The python is 29½ feet long, weighs 280 pounds, and is nearly 100 years old.

While being removed from the ship, the reptile's neck was caught on a spike and badly torn.

A veterinarian having been called in, a muzzle was placed over the snake's head, and the 14-inch wound was sewed up with silk thread. When the wound did not heal satisfactorily after 10 days, it was resewed with silver wire.



Surgeons stitching a 14-inch wound in neck of 280-pound python



Metal Paper Clasp Finds Many Office Uses

A METAL paper clasp, designed to hold from two to 100 sheets, thus eliminating the necessity of keeping in stock several sizes of clasps, has recently been placed on the market by a concern in Cleveland, Ohio.

When hooked over the edge of a desk, the clasp can be used to prevent loose papers from being blown about. It can be used also to retain loose sheets on the inside of book and ledger covers.

Small Glass "Bomb" Serves as Fire Extinguisher

ABOUT 90 per cent of the annual fire loss might be prevented, experts say, if it were possible always to have at hand a means of immediately extinguishing the flames. A simple new appliance for this purpose is in the form of a bulb resembling



How bulb extinguisher hangs in bracket

a large electric lamp, filled with a fire smothering liquid. The bulb rests in a wall bracket.

If a fire starts, it is necessary only to hurl the bulb into the flames. A partial vacuum above the liquid in the bulb causes an inrush of air when the bulb breaks, scattering the liquid and smothering the fire quickly.

Light, Sturdy Boats Built of Concrete



Concrete rowboat formed by plastering cement mixture over mold of wire mesh

A CONCRETE rowboat is the latest achievement of T. A. Brouwer, of Westhampton, N. Y., whose hollow concrete statues were described in the January issue of POPULAR SCIENCE MONTHLY.

In constructing the boat, he built a hollow mold of rough lumber, over which he stretched wire mesh as a base for the concrete. Over the mesh he plastered

the cement mixture to a thickness of one half inch. The inventor claims, however, that a shell of one quarter inch thickness provides sufficient strength for the average rowboat.

The novel craft is said to compare favorably in weight with a wooden boat, with resiliency sufficient to withstand ordinary shocks; moreover, it can be cheaply and quickly built.

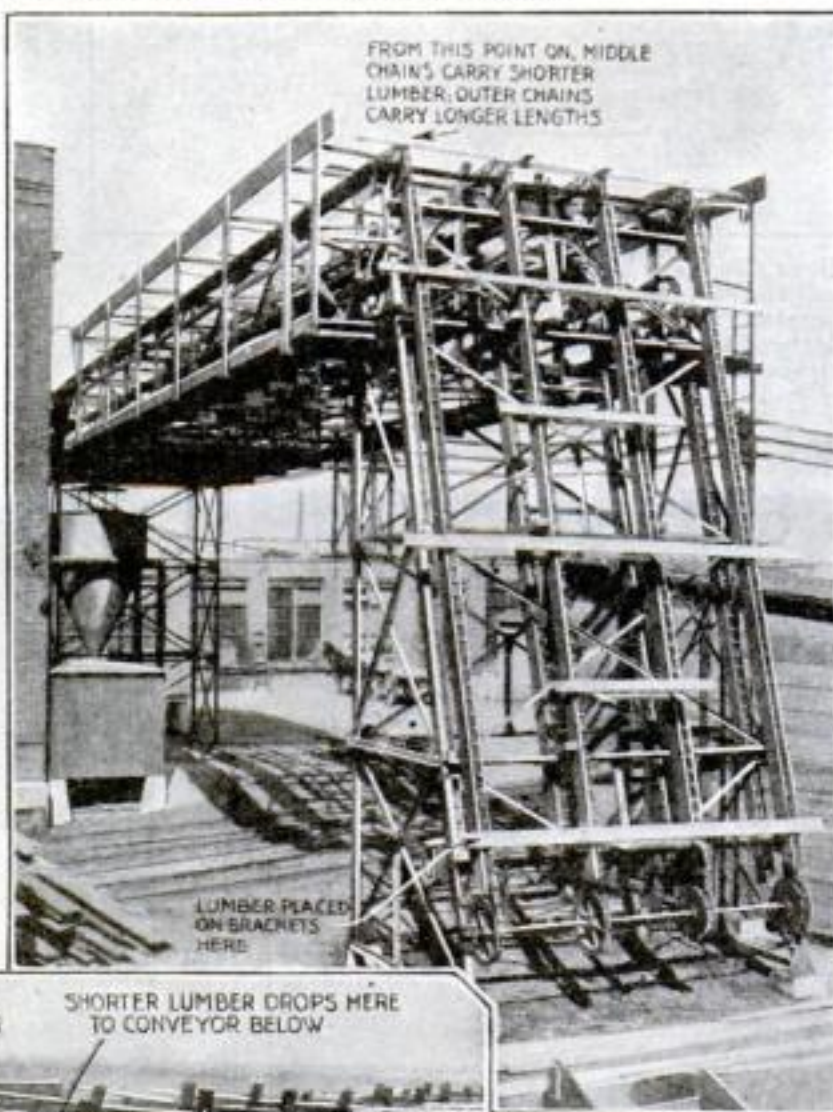
Chain Conveyors Sort Lumber by Length

A LUMBER handling machine equipped with conveying chains and brackets that elevate the lumber, sort it into various lengths, and finally carry it to the places where it is to be used, is saving much hand work and trucking in a factory at Niagara Falls, N. Y.

The mechanism includes three conveyor systems. One is an elevator; a second carries short pieces of lumber, and a third is for long pieces. In the elevator are four parallel chains moving on sprocket wheels. Projecting from the two inner chains are brackets on which lumber of various lengths is placed piece by piece.

When the lumber reaches the top of the elevator, and begins to travel horizontally, the two inner chains are depressed so that all lumber that is shorter than the distance between the outer chains is carried at an elevation three inches lower than that of the longer pieces traveling on the outer chains.

Arriving at the upper sprocket wheels of the elevator, the short pieces drop to the short piece conveyor, while the long pieces continue their journey on the outer chains to the third conveyor.



FROM THIS POINT ON, MIDDLE CHAINS CARRY SHORTER LUMBER; OUTER CHAINS CARRY LONGER LENGTHS

LUMBER PLACED ON BRACKETS HERE



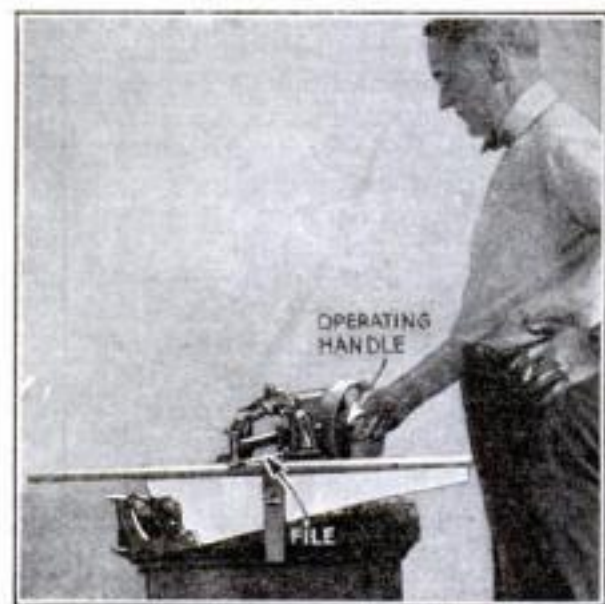
LONGER LUMBER DRAWS AHEAD OF BRACKETS BECAUSE OF GREATER SPEED OF OUTSIDE CHAINS

SHORTER LUMBER DROPS HERE TO CONVEYOR BELOW

BRACKETS

CONVEYOR

Above: The elevating conveyor, showing how long pieces of lumber rest on outer chains and shorter pieces on inner chains. At left: Where lumber is sorted, the short pieces dropping from the inner conveying chains to a conveyor below, while longer pieces continue on their way



Filing Machine Sharpens Saws Automatically

MECHANICAL saw filing has been a problem for inventors for some time and in consequence much interest attaches to the recent invention of a saw filing machine which the designer, H. B. Foley, of Minneapolis, Minn., claims performs the operation as satisfactorily as hand work.

The mechanism has four moving parts—a horizontal moving carrier, which holds the file; a vertically moving guide frame in which the horizontal carrier slides; a fly or hand wheel for propulsion, and a regulating cam.

A standard file is mounted upon the horizontal carrier and its pressure against the saw teeth is maintained by two small springs. The file is then moved across the saw by the action of the guide frame moved by the rotation of the handwheel. After the completion of a stroke, the cam raises the file, which is returned to its original position and is again lowered upon the saw by the same cam.

After a definite number of file strokes, the saw moves forward automatically in accordance with the setting of an adjusting screw. This screw governs feed pawls that engage in the saw teeth and move the saw forward after a definite number of file strokes.

The vertical guide sash can be fastened at any angle for making any angular cut. When the teeth have been filed on one side, the saw is reversed.

My Greatest Discovery in Fifty Years

Famous Plant Wizard, Celebrating Half a Century of Useful Labor, Tells How He Believes We Can Develop Better "Human Plants"

By Luther Burbank, Sc.D., Especially written for POPULAR SCIENCE MONTHLY

ON THE seventh day of March, I was 74 years of age. On that day, I celebrated the conclusion of half a century of ceaseless experimentation with plant life.

In those 50 years, millions of plants—grasses, flowers, vegetables, grains, and trees—have passed through my hands, and from them I have selected a few, seemingly a very, very few, for preservation, reproduction, improvement, development, to such a point that they may render the utmost service of food, beauty, and enjoyment to man.

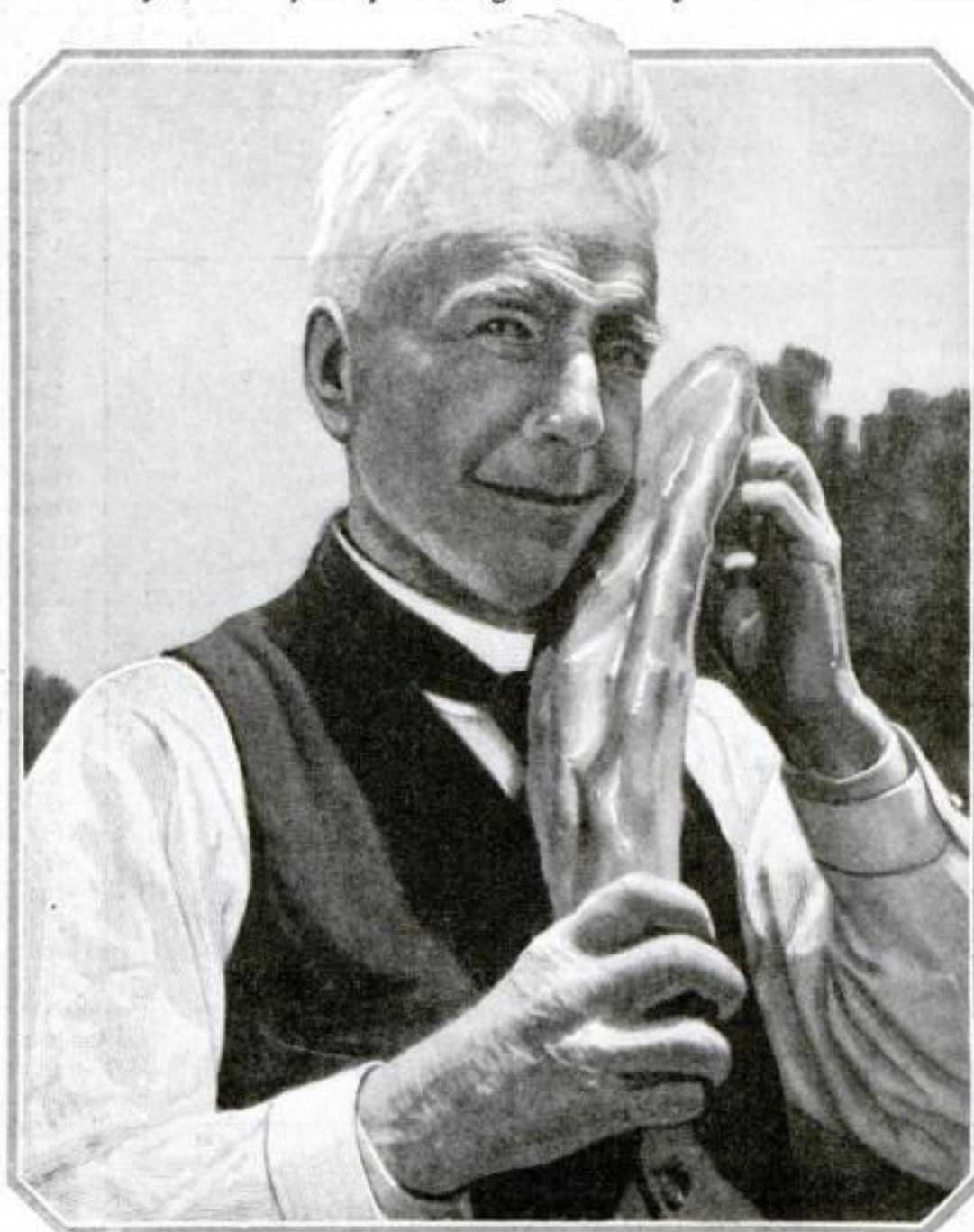
Plants Teach Man

To me, they have become like a vast army of individuals, marching onward, guided by selection, toward a goal of improvement. From my first creation—a potato that is now grown by the millions of bushels all over the habitable globe—to the latest of more than a dozen varieties of new and commercially valuable fruits—of which more than 100 car-loads were shipped last year from California alone—there has been growing steadily within my experience the belief that in the development of the plant lies a great, if not the greatest, object lesson for human beings.

That belief has grown in 50 years to a



By crossing species of wild cactus under protected conditions where spines were unnecessary as protection, Burbank produced his famous spineless cactus, at right. A wild, spined cactus is shown above



The Grand Old Man at 74

"SMOOTH as silk; feel it!" Here is America's grand old man of plant breeding—Luther Burbank—as he appears today at the age of 74, testing against his wrinkled cheek the smoothness of the spineless cucumber, one of the many remarkable creations of his half century of wizardry. On the occasion of California's celebration of his fiftieth year of labor, Burbank has written the accompanying article for POPULAR SCIENCE MONTHLY readers

of the survival of the fittest, as an explanation of the development and progress of plant life, I have come to find in the crossing of species and in selection, wisely directed, a great and powerful instrument for the transformation of the vegetable kingdom along lines that lead constantly upward.

The crossing of species to me is paramount. Upon it, wisely directed, and accompanied by rigid selection of the best, and as rigid an exclusion of the poorest, rests the hope of all progress.

In my work with plants and flowers, I introduce color here, shape there, size or perfume, according to the product desired. In such processes the teachings of Nature are followed; its great forces only are employed. All that has been done for plants and flowers by natural crossing, Nature already has accomplished for the American people. By the crossing of types, in

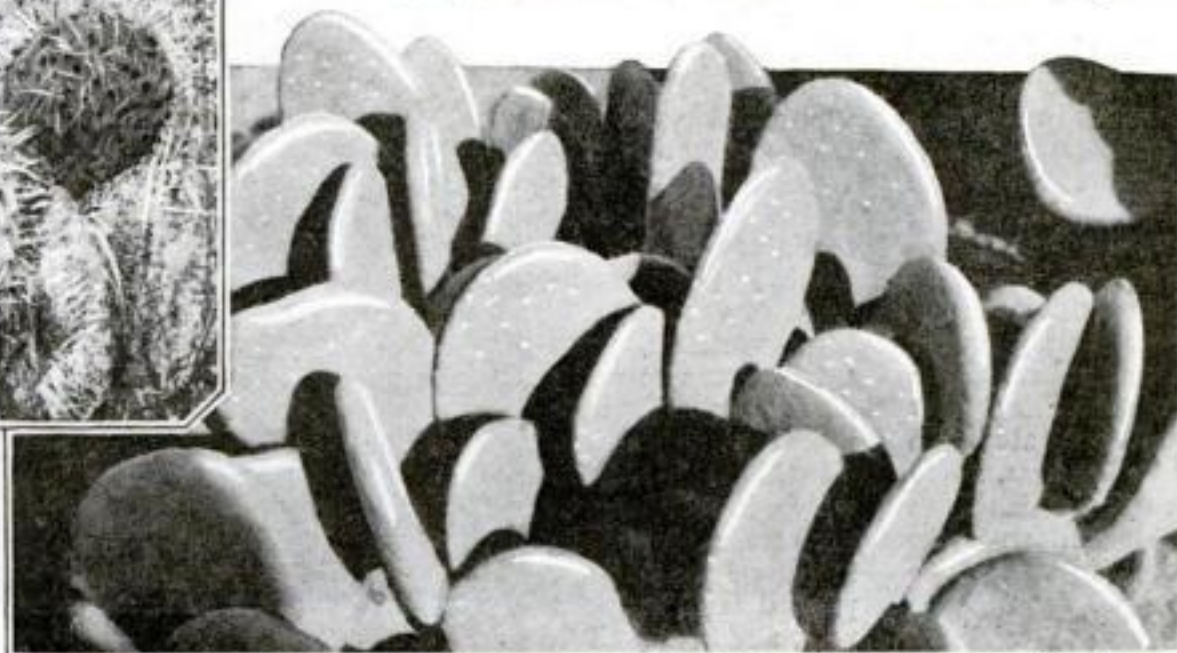
fact. It has been proved time on time, and I have crystallized it into two statements, one the corollary of the other:

First, that plants are pliable and under the control of man; and that they can be bred and trained and developed, just as animals can be bred and improved and trained.

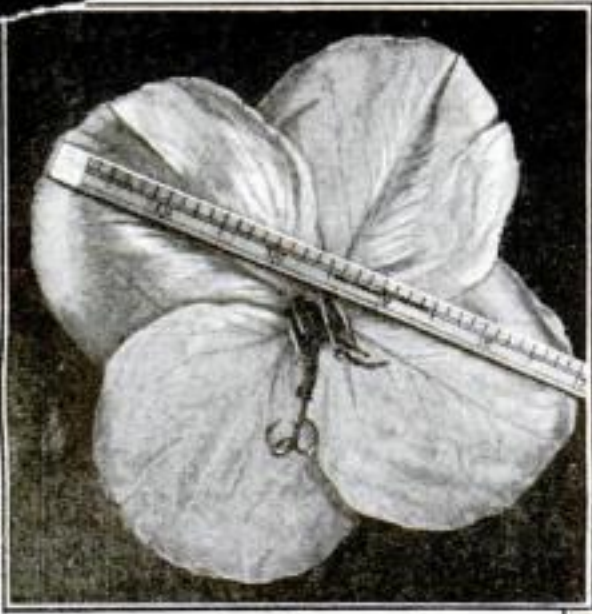
Second, that the human plant—the child—can be trained, developed, and improved, just as the skilled gardener, or the trained botanist, trains, develops, and improves the best that is in each one of his plants.

The Hope of Progress

During the course of many years of investigation into the plant life of the world, creating new forms, modifying old ones, adapting others to new connections, and blending still others, I have been impressed constantly with the similarity between the organization and development of plant and human life. While I have never lost sight of the principle



The spineless cactus, which Burbank considers one of his most valuable discoveries, because it "converts waste lands into pastures capable of supporting cattle, hogs, and sheep"



More than five inches in diameter, the wonderful Burbank evening primrose above was developed by careful selection from wild evening primroses of California, such as those shown at the right

one instance, strength has been secured; in another, intellectuality; in still another, moral force. Nature alone has done this. But the work of man's head and hands has not yet been summoned to prescribe for the development of a race. So far, a preconceived and mapped-out crossing of bloods finds no place in the making of peoples and nations. But, when Nature has already done its duty, and the crossing leaves a product that in the rough displays the best human attributes, all that is left to be done falls to selective environment.

In my life work, when two different plants have been crossed, that is only the beginning. It is only one step, however important; the great work lies beyond—in the care, the nurture, the influence of surroundings, selection, the separation of the best from the poorest; all of which are embraced in the words I have applied—selective environment.

Just as all plant life is sensitive to environment, so is all animal life. And of all living things the child is the most sensitive. Surroundings act upon the child as the outside world acts upon the plate in the camera. A child is the most susceptible thing in the world to influence, and, if that force be applied rightly and constantly when the child is in its most receptive condition, the effect will be pronounced, immediate, and permanent.

The Child a Human Plant

We should begin with the child where I begin with the plant, at the very beginning. It has been said that "the way to reform a man is to begin with his grandfather;" but this is only a half truth, for, while it is true that we should "begin with his grandfather," we should begin with that grandfather when he himself is a child.

The secret of the successful results of my work with plants has been partly in my love for plants. If you are cultivating a plant, developing it into something finer and nobler, you must love it, not hate it; be gentle with it, not abusive; be firm, never harsh. I give the plants upon which I am at work the best possible environment. So it should be with the child, if you wish to develop it along right ways. Let it have music, pictures, laughter, and a good time; not an idle time, but one full of cheerful occupations. Plants should be given sun

and air, blue sky, and proper nourishment. Give them to your boys and girls.

Choose what improvement you wish in a flower, a fruit, or a tree, and by crossing, selection, cultivation, and persistence, you can fix this desirable trait irrevocably. Pick out any trait you want in your normal child, be it honesty, fairness, purity, lovable-ness, industry, thrift, what not. By surrounding this child with sunshine from the sky and from your own heart, by giving him the closest communion with nature, by feeding him well balanced, nutritious



food, by giving all that is implied in "healthful environment influences," you can thus cultivate in the child all of these traits, and fix them for all his life.

These are the most important discoveries, certainly the most valuable, that I have made in my half century of selecting, training, developing, and improving the members of the vegetable kingdom. In that time, I have passed through a million interesting experiences, not the least of which has been to watch the development, through years of experimentation, of productive, useful plants from forms that before had been comparatively worthless. I have looked down upon a miniature forest of 240,000 plum seedlings, of as many distinct varieties, from which I was to make a selection, right here in my own grounds, of ONE TREE, which, in turn, was to produce a plum that ripened rapidly, packed well, shipped well, and sold well in the market.

I have had the

pleasure of developing a chestnut—a tree that normally requires from 15 to 20 years to come into full bearing—into a tree that bears nuts at six months from the planting of the seed nut, and is in full bearing at two years.

From the small, hard, bitter quince I have developed, by selection and crossing, a fruit larger than the largest apple, juicy and sweet when eaten raw, and as fine in flavor as the most delicious apple when baked. There is nothing in that quince except the best qualities of the original quince, but it has been given encouragement and opportunity to develop to its utmost, and it has responded, just as any other plant, animal, or child will respond and develop if so cared for.

I have taken the slow growing, small, hard-shelled wild black walnut and, by crossing it with the soft-wooded, soft-shelled, edible walnut, produced a tree with a finer, harder wood than the black walnut, yet which grows many times as rapidly as the latter and produces better and more nuts.

Prune Trees from Almonds

From the crossing, selection, and development of young trees of the common prune within the past 40 years, I have developed a larger, sweeter, earlier fruit, which dries better, ships better, keeps better, and sells better. I recall one time, back in 1881, when Warren Dutton, a friend of mine, came to me in March for 20,000 prune trees, to be ready for setting out *that same year*. This meant the planting, and growing to a height of from two to five feet, of 20,000 prune trees within nine months. I took the contract, and this is what was done:

Twenty-five thousand almonds were spread over a bed of well-drained creek sand, and covered with a thickness of



This giant artichoke, 14 inches in diameter—nearly four feet in circumference, developed from smaller varieties with which we are familiar—is one of many marvelous new plant creations announced for this spring by Luther Burbank



To help the poultry raiser, Burbank created these dwarf sunflower plants, greatly shortening the stalk of the usual species and turning the blossoms face downward, so that poultry may help themselves to the seeds

burlap, over which was laid an inch of sand, kept moist. The almond seeds had the proper environment and the best of care. In two weeks they were sprouting. One by one, as they sprouted, they were set out in rows, four inches apart.

In June, when they were a foot or more high—still being *almonds*, mind you, while I wanted *prunes*—I obtained from a neighboring prune orchard, 25,000 prune buds, employed a budding crew of 16 men, and inserted the prune buds in the almond seedlings. Prune shoots appeared from the buds, the tops of the almond trees were cut away, and I had, not quite 20,000, but about 19,800 young prune trees, ready for delivery, and ready on time. They made an orchard of more than 200 acres, and, though that bit of work was done nearly 42 years ago, all of them are still growing and bearing abundantly.

Man Can "Go Nature One Better"

It is all so simple; life in every form is so clear; it is all a process of evolution. And man, by perseverance, patience, watchfulness, study, care and love, may aid im-

measurably in the processes of that evolution. He may accomplish in 10 years what Nature takes 10 centuries to do.

For more than half a century I have had one definite object—the improvement of the vegetable kingdom for the benefit of man. Deciding first, exactly what I wish to create, I begin by selecting the strongest, best developed plants of that variety available. They come to seed, the best seed from them is planted again, and again developed for further selection and planting; cross fertilization by pollen is carried on, and so the work continues until the ultimate product of that particular parent stock is reached. There is nothing supernatural, nothing mysterious about it. It is a work into which I gladly, joyously put my heart and mind and hands.

Just now, I am trying to produce better grains, nuts, fruits, and vegetables, as well as larger, more beautiful, and more fragrant flowers, striving not only for new forms, colors, and sizes, but for those products of the vegetable kingdom that will provide more food and less waste.

On my experimental farms, more than 2500 experiments are being conducted. I

shall have ready, this spring, a variety of new grains, seed-bearing grasses, suitable for both forage plants and for grain crops, and others for cereals; new walnuts, huge, rapid-growing hardwood trees, which will produce more valuable lumber in 10 years than the now well-known varieties will in 50 or 100 years; a drought-resisting lippia for lawns in dry regions; a new asparagus, which is to the ordinary variety as the Burbank potato was to its predecessors; an artichoke, the blossom of which is four feet or more in circumference; and a number of new climbing vines and flowers.

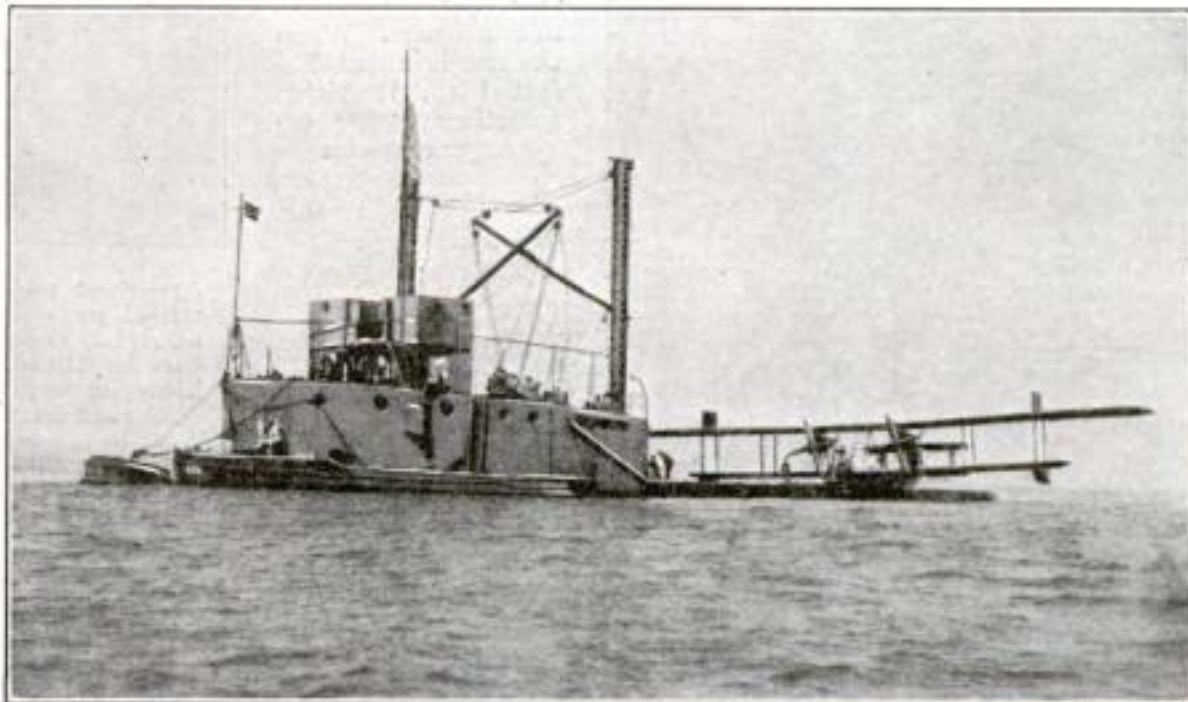
Burbank Promises Future Marvels

Among the new blossom-bearing plants I shall offer soon, are immense larkspurs, both annual and perennial; new zinnias, larger and brighter than any before known; new petunias and a verbenas with much larger flowers and a pleasing odor. There are to follow, within a year or so, still more interesting and valuable productions from the work of selection, development and improvement that I have been doing in the plant world for the last half century.

Floating Seaplane Dock for Ocean Airline Way Station

A RECENT development in the project to establish transatlantic commercial air service, comes in the form of a new seaplane dock, built by the British air service.

The difficulty of anchoring such way stations has been overcome theoretically by the invention of a deep sea anchor by E. R. Armstrong, of Wilmington, Del., described a year ago in *POPULAR SCIENCE MONTHLY*. By anchoring a series of



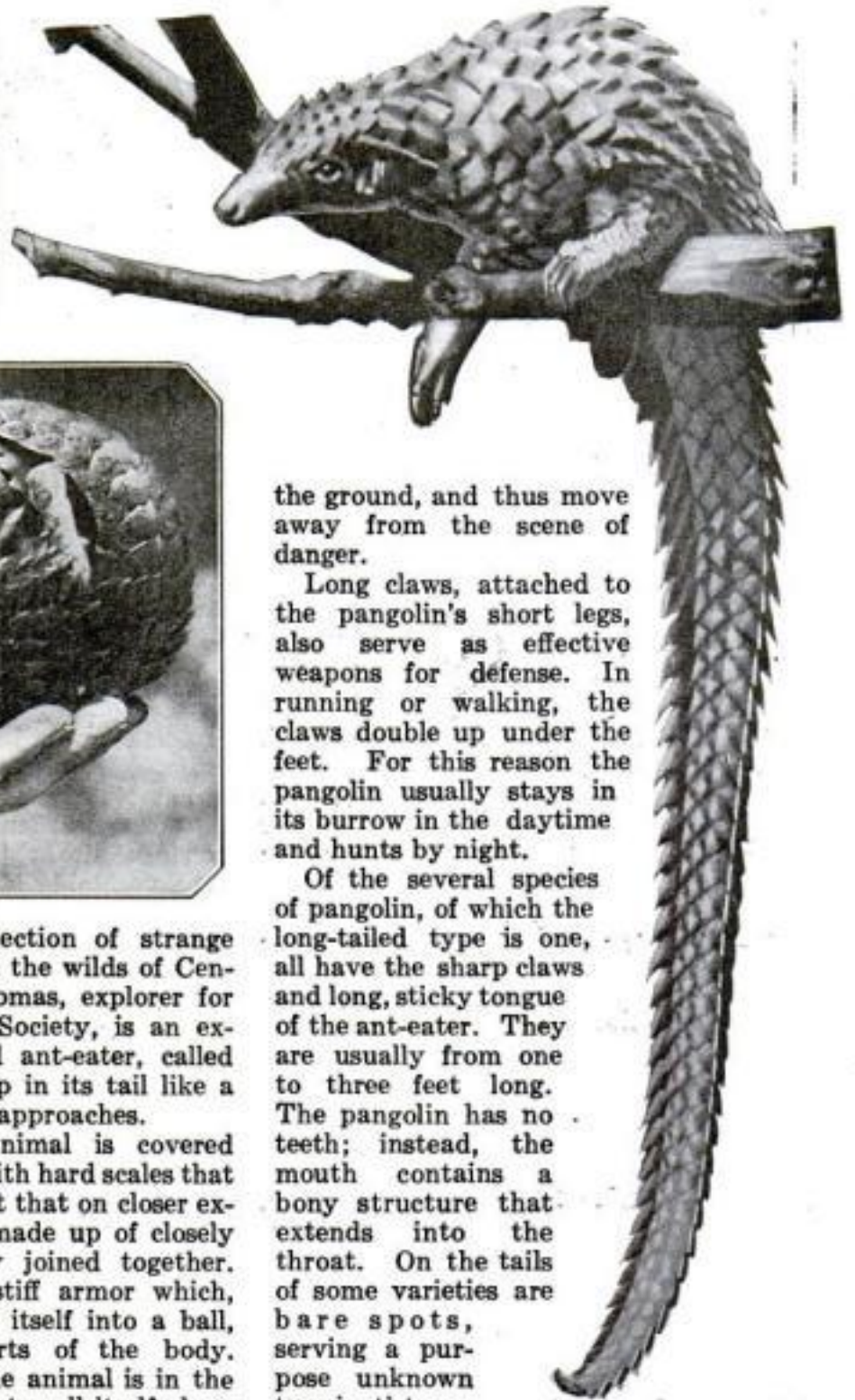
The anchored dock, showing seaplane high and dry on wharf. A series of these docks is proposed for transatlantic flights

these docks in a line from America to Europe, using heavy deep sea anchors, it will be possible for planes to cross the Atlantic in a number of short jumps.

In this way planes would not need to carry excess weight, for they could procure additional fuel at the way stations. The danger of a long flight over water would be materially reduced, for service ships plying between stations could aid any plane in distress.

Scaly Ant Eater Rolls Up in Its Tail

At the approach of danger, this strange long-tailed ant-eater from Central Africa wraps itself up in its tail to form a ball, as shown below. The animal then rolls away from the danger spot. Note the armor-plate scales that protect the entire body when rolled up



the ground, and thus move away from the scene of danger.

Long claws, attached to the pangolin's short legs, also serve as effective weapons for defense. In running or walking, the claws double up under the feet. For this reason the pangolin usually stays in its burrow in the daytime and hunts by night.

Of the several species of pangolin, of which the long-tailed type is one, all have the sharp claws and long, sticky tongue of the ant-eater. They are usually from one to three feet long. The pangolin has no teeth; instead, the mouth contains a bony structure that extends into the throat. On the tails of some varieties are bare spots, serving a purpose unknown to scientists.



Scoop Trowel Saves Time in Bricklaying

AS AN improvement in the science of bricklaying, which has remained practically unchanged for many centuries, Oscar F. Mann, of Indianapolis, Ind., has invented a trowel which, it is claimed, will enable the bricklayer to lay from two to four times the usual number of bricks.

The trowel is in reality a scoop with sloping sides and a projecting point. In use, the implement is first moistened by dipping in a pail of water, then filled with very wet mortar. By inverting the trowel and drawing it along a row of bricks, the bricklayer is able to distribute the mortar very evenly over the surface at exactly the correct thickness to receive the next layer of bricks.

An advantageous way to use this trowel is for the bricklayer's assistant to spread the mortar, while the bricklayer himself lays and points up the succeeding rows. In this way one man may become very proficient in laying mortar, while the other becomes expert in laying bricks, incidentally economizing on time.

IN A remarkable collection of strange animals brought from the wilds of Central Africa by Seth Thomas, explorer for the London Zoological Society, is an extraordinarily long-tailed ant-eater, called "pangolin," that rolls up in its tail like a ball whenever an enemy approaches.

This lizard-shaped animal is covered from head to tip of tail with hard scales that appear to be of bone, but that on closer examination prove to be made up of closely woven hairs all tightly joined together. These scales serve as stiff armor which, when the pangolin rolls itself into a ball, covers all exposed parts of the body. Strange to say, while the animal is in the form of a ball, it is able to roll itself along

Dwarf Orange Tree as a House Plant



WITH the introduction of the Chilean dwarf sweet orange, the Department of Agriculture promises that soon we may grow oranges in our homes. When the tree is about 2½ feet high, it yields sometimes 2000 oranges a season



Attached to the wheel as shown at right, the fan can be tilted to blow in any direction



Sewing Machine Runs Fan

ATTACHED to the flywheel of a sewing machine a novel rotary fan has been perfected by a manufacturer in Atlanta, Ga., to keep the seamstress cool.

The fan, which has four blades tilted to throw the air in the direction of the operator, is arranged so that it can be sprung easily into the wheel to rotate with it.

Will Gyroscopic Wheel Shatter Speed Records?

DOWN the track of a motor speedway a wheel 14 feet high whirls at such a dizzy speed that racing automobiles traveling at top speed—115 miles an hour—seem almost to stand still. So fast does the giant wheel travel that the details of its design can scarcely be distinguished.

This is a possibility prophesied by Prof. E. J. Christie, of Marion, Ohio, for an amazing gyroscopic unicycle of his invention, now being constructed in Philadelphia, Pa. The 2400-pound 14-foot model of the speed wheel is almost ready for a trial spin and Christie confidently predicts that it will develop a speed of at least 250, and possibly 400 miles an hour!

In design, the strange vehicle resembles a giant bicycle wheel with an exceptionally long hub, at the end of which supporting spokes are fastened. Attached to the axle, on each side of the center are 500-pound gyroscopes designed to rotate at a speed of 90 revolutions a minute—a speed sufficient to maintain equilibrium.

Suspended from the axle by a frame, the upper end of which supports the driver's seat, is a 250-horsepower airplane motor, the power of which is transmitted to the axle through a friction clutch, three-speed transmission, and jackshaft. An additional chain drive in the center of the axle connects the engine transmission with the gyroscopes.

The machine is controlled and operated like an automobile from the operator's seat immediately above the axle. Here the driver is saved from swinging about the axle by the steadying weight of the engine slung below.

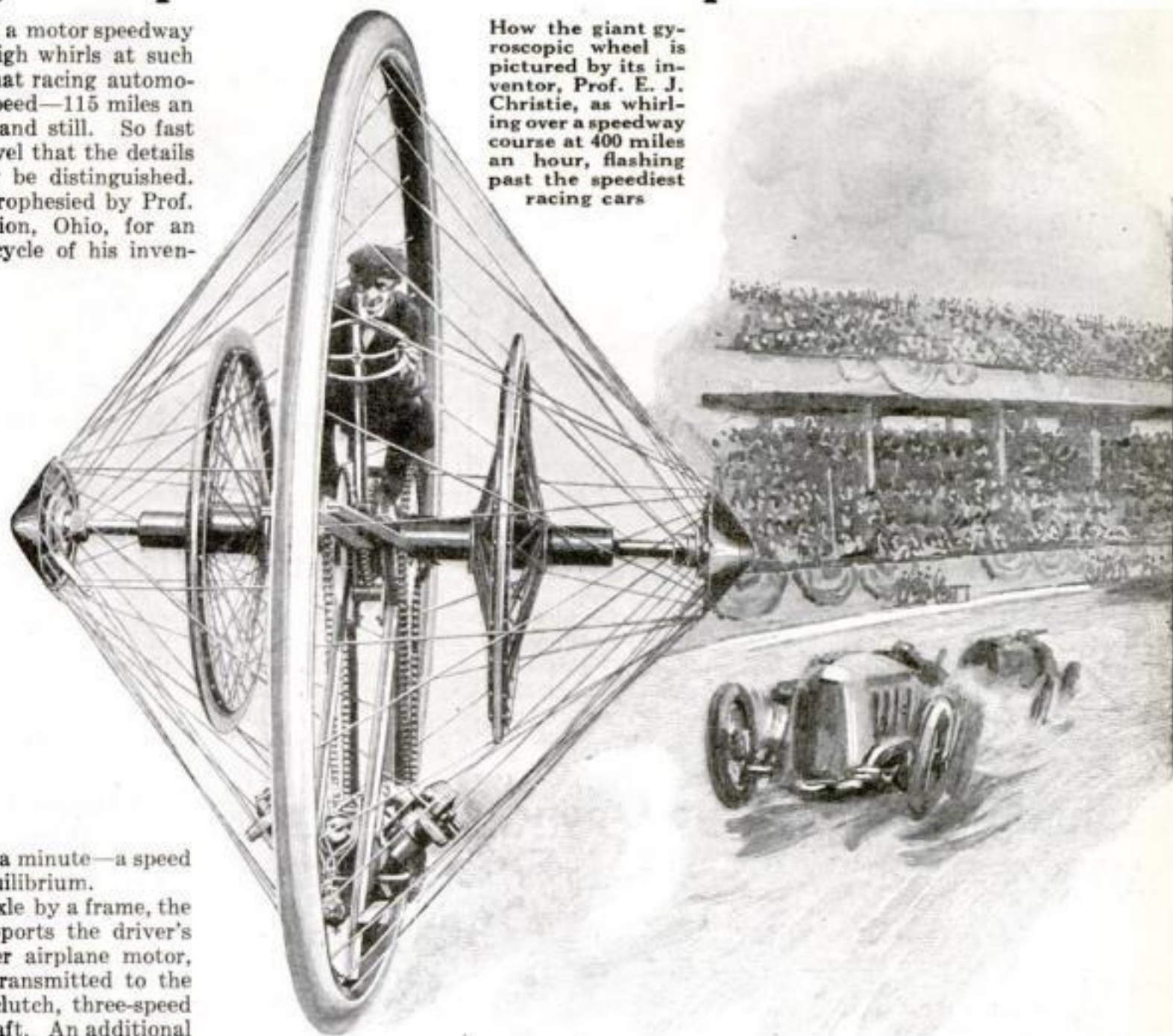
"How can such a strange vehicle be turned?" you may ask.

This problem Professor Christie has

solved in a unique way. By means of the steering wheel, he shifts the position of the two gyroscopic flywheels on the axle to the right or to the left. When the center of equilibrium is thus shifted, the unicycle immediately turns in its course, without tilting, the degree of turn depending upon the distance the gyroscopes are shifted. In other words, the farther the shift, the shorter the turn.

The wheel is supplied with a seven-inch

How the giant gyroscopic wheel is pictured by its inventor, Prof. E. J. Christie, as whirling over a speedway course at 400 miles an hour, flashing past the speediest racing cars



rubber tire, the manufacture of which proved a problem in itself. Pressure resistance was found to be so great that several attempts were made before a strong enough tire was produced.

The new gyroscopic unicycle is not the first machine of its kind Professor Christie has produced, although it is by far the most pretentious. He first used a gyroscope to demonstrate the rotation and momentum of the earth.

Automatic Conductor Makes Change on Pay-as-You-Leave Car



At the exit, a turnstile opens when nickel is deposited



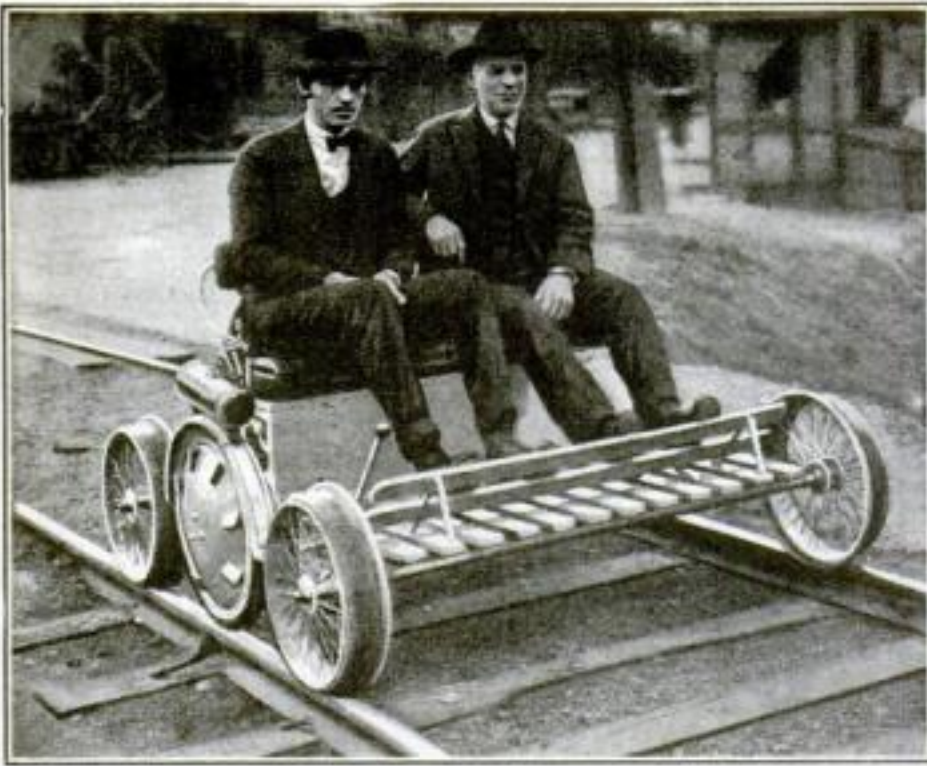
The high-speed change-making machine supplies exact change

A PAY-AS-YOU-LEAVE trolley car, equipped with an automatic cashier and turnstile, has made its appearance in New York City. Passengers entering pass through a turnstile, which registers the number of occupants in the car at any time. A high speed automatic change making machine is located just inside of the entrance door and supplies the passengers with exact change, a nickel being always part of the change returned.

Turnstile Keeps Record of Fares

Before leaving the car, passengers must pass through another turnstile which operates only when a nickel has been inserted in a slot. By moving in one direction when a person enters, and in the opposite direction when one goes out, the turnstile keeps a record of the number of passengers in the car at any time.

When the car's capacity is reached, an automatic sign on the roof displays the word "Full."



Power Wheel Drives Handcar

THE small, trailing wheel engine attachment for bicycles, which saves so much of the cyclist's energy, has found a new application as an attachment for railway inspection cars.

The auxiliary wheel is attached to the side of the car and runs on the top of the rail, transmitting its power through rubber tires.



Cranks Plane from Cockpit

IN FRONT of the pilot's seat in the first metal airplane to be completed in the United States is a horizontally turning crank that enables the aviator to crank the motor without leaving the cockpit.

The plane has been constructed for the Navy Department and has made successful trial flights at Martin Field, Cleveland, Ohio.

Single Slashing Cut Opens Tin Cans

A READY means of opening cans of preserves is provided by a new can opener, which cuts a circular slit almost entirely around the top of the tin when forced down by pressure with the palm of the hand.

Into the flat handle of the instrument is cast a cylindrical blade that has been cut at an angle to form a sharp point in front. The entire edge of the blade is sharpened, so that when the point is placed near the edge of the can top and pressure is applied, the cylinder makes a circular incision, leaving only a small section of uncut tin, which serves as a hinge when the cut top is raised.



Handy Pocket Case for Micrometer Caliper

TO MANY engineers and mechanics, the small micrometer caliper is an instrument that must be constantly within reach yet carefully protected from dust and dirt. For this reason a tool manufacturer of Providence, R.I., has turned out a



How the caliper fits snugly into convenient case

caliper case, resembling an eyeglass case, so small that it can be carried conveniently in the pocket.

The case, lined with plush and covered with leather, has been designed to form a practical and efficient receptacle for this delicate instrument.

Novel Electric Signals for Tramway



Using a pole to short circuit tramway wires on the Pitt River power project, Calif., the tramcar operator signals the engineer to raise the car

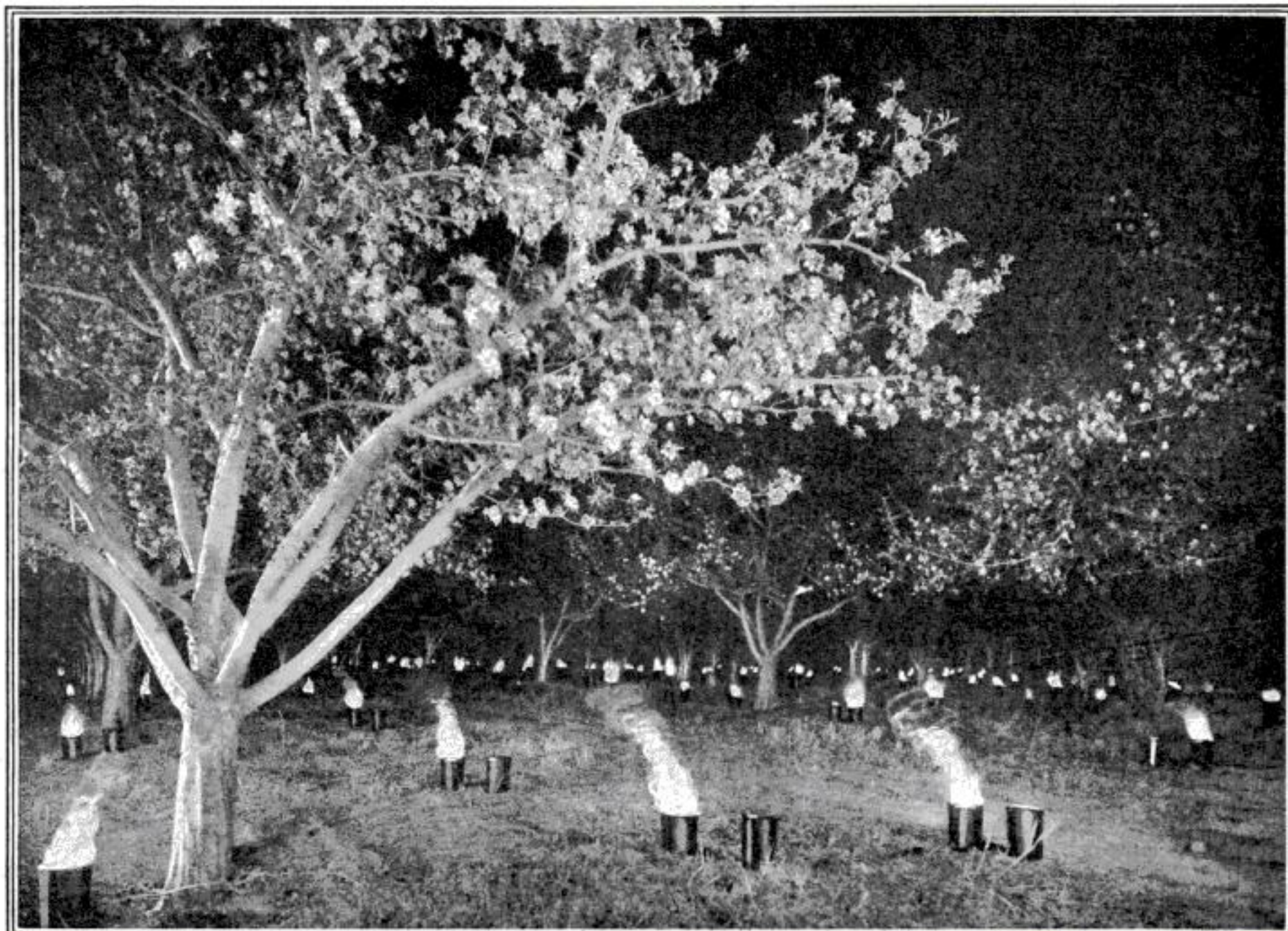
Scientists Produce World's Shortest Radio Waves

ESTABLISHING further proof of the theory that light, heat, and electric waves are identical in character, Drs. E. F. Nichols and J. D. Tear, of the Nela Research Laboratories, Cleveland, Ohio, recently announced that they have produced electric, or radio waves only one fiftieth of an inch long. These are the shortest known radio waves, and are identical in length with the longest heat waves.

This achievement, accomplished with the aid of instruments more sensitive than heretofore available, marks the joining of the electric wave and heat wave spectra. In the experiments two types of electric wave receivers were used to detect and re-measure the long heat waves, about one third of a millimeter in length, that were obtained by two scientists, Rubens and Von Baeyer, in 1911.

Ordinary radio transmission is by electric waves measuring from 200 meters (nearly 700 feet) to 15,000 meters (about 10 miles).

Gong Alarms and Oil Burners Rout Killing Frosts



© P. H. Troutman

This remarkable nighttime photograph of a blossoming Colorado apple orchard shows how flaming oil burners are used to protect trees from killing frost. From 25 to 50 of these burners are used to the acre

MODERN science is at last achieving victory over one of the most deadly and destructive peace enemies he knows—Jack Frost.

For centuries man has had to stand by, helplessly witnessing the spectacle of his carefully nursed crops falling before the silent onslaught of early spring frosts. Often a killing frost would creep upon a garden or orchard without warning while the farmer slept—and the next morning he would watch his valuable crop wilt under the rays of a warm sun.

Now, however, the scientific farmer can go to bed knowing that a gong will ring and waken him if Jack Frost is about to make a visit. This warning is sent out by thousands of electrically connected thermometers that ring a gong when the thermometer drops to a danger point.

Night Riders of Pacific Coast

Another system now in vogue on the Pacific Coast is the use of night riders—men who patrol large districts and inspect government tested thermometers. Some of these districts embrace 30 or 40 square miles, with as many as seven routes, 500 telephones, and 126 thermometers. Each rider reports his readings to headquarters, from where general alarms are sent out on the approach of a killing frost.

As soon as the farmer is warned of frost, either by electric thermometers or by the night rider, he sets out to fight frost with heat. Although several kinds of fuel are

used for artificial heating, the modern automatic feed oil burner has proved most effective, except in localities where there is a large accessible supply of wood. Many Oregon farmers have saved their crops by burning old stumps and rails, thus protecting orchards that produce \$1000 worth of apples an acre later in the season.

Oil Burners in Great Favor

But the oil burner is finding increasing use. The Colorado or Troutman heater, developed by P. H. Troutman of Canon City, is being used in every state in the Union. This heater with an oil capacity as high as six gallons, has a center tube or chimney that creates a draft and aids perfect combustion. It is made in three sections. A lower section forms the reservoir, a center or combustion chamber is fitted with a rim with a short apron, and at the top is a large cover. Increased heat as high as 50 or 60 degrees is obtained by removing the rim or collar, while still greater heat is obtained by removing the cover.

In many large orchards heaters of this type have successfully brought delicate blossoms through severe frosts without damage, from 25 to 50 heaters being used to the acre. Smaller heaters, equipped with attachments that deflect the heat in any direction desired are used to protect strawberries, raspberries, and other small fruits and vegetables.

Frost occurs whenever the mercury drops to 32 degrees or lower. This drop con-

denses and freezes particles of moisture on plants and creates what is known as "white frost." If no water from the air is condensed, the result is a "black frost." A permanent freeze results from low temperature accompanied by high winds.

During the day, the earth receives more heat than it can throw off. Continually the heat that the earth discharges rises to colder layers of air above, and the colder air flows down, to be warmed in its turn. At night the earth's heat supply is shut off, yet it continues to pass out heat from its reserve supply, and as a result the colder air continues to pour in at the surface. In spring and fall this air sometimes becomes cold enough to cause a frost, especially after a rainy period when the earth has little heat saved up.

Putting Heat in the "Bank"

The most common way of keeping the earth from giving away its heat is to furnish it with a heat "savings bank." Glass is just such a "bank," for it allows the heat from the sun to pass through to the earth, but will not allow the radiated heat from the earth to pass back. Glass, however, is expensive and cannot be used on large areas. Wood, while it does not allow the sun's rays to pass through, is used in the South to cover crops.

Paper, although less efficient, is often used for the same purpose. Some crops, especially cranberries, are saved from frost by flooding the field with water.

Huge Steel Viaduct Moved Bodily for 75 Feet

THE amazing feat of moving side-wise, for a distance of 75 feet, an entire steel viaduct 740 feet long and 150 feet high (at its highest point) without interrupting foot traffic across it, was recently accomplished by a Pittsburgh engineering firm. The seemingly impossible task was completed in 14 hours of actual work, although nearly six weeks were required for preparations.

When first the feasibility of moving Jacks Run Bridge, near Pittsburgh, Pa., was considered, one engineer expressed the belief that the bridge could be moved if the rusted steel floor were immediately reinforced. This was done and work preparatory to moving the bridge began, although several engineers prophesied failure.

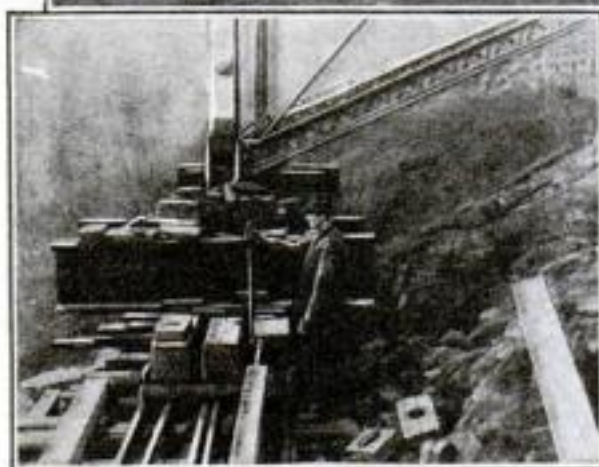
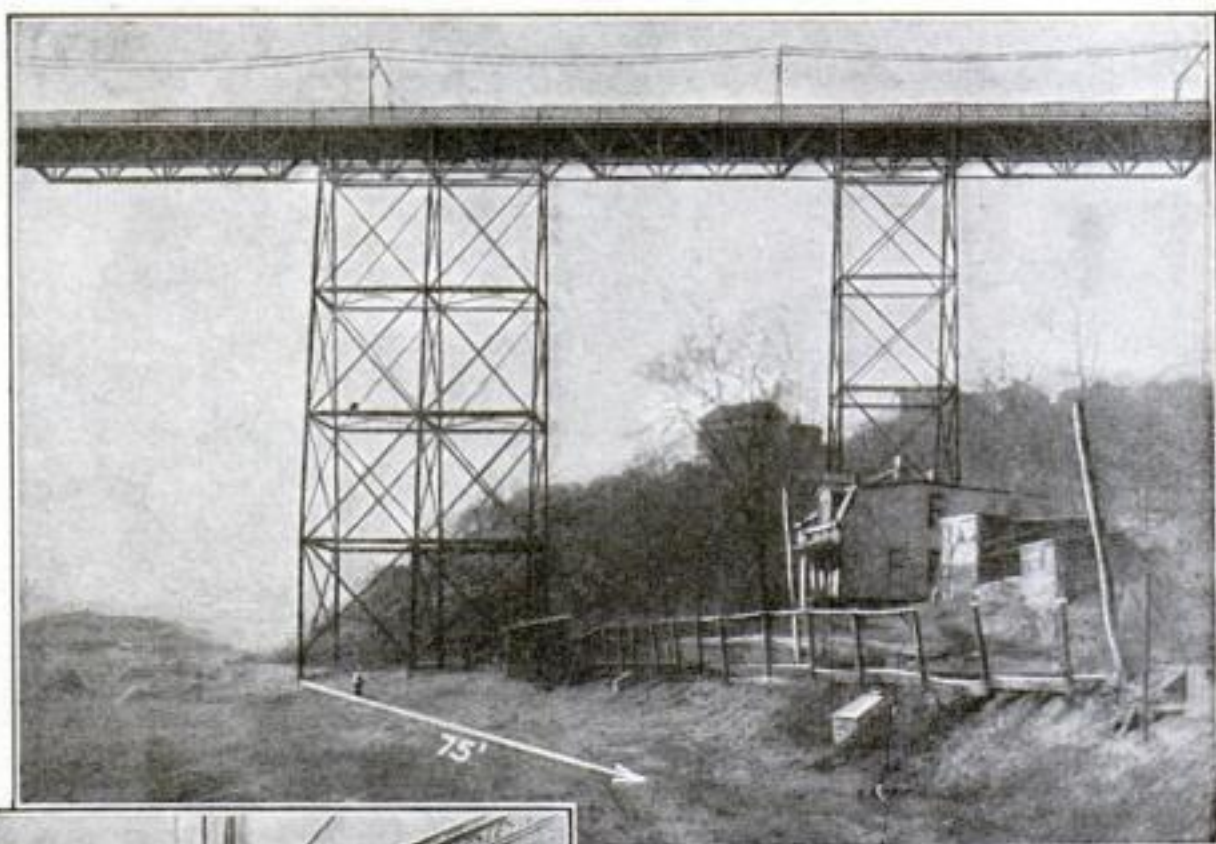
Bridge Travels on Rollers

Concrete piers and earth-filled timber abutments were erected at the spot chosen for the new location of the bridge—75 feet away from its original location. Along the path over which the bridge was to move, cribbing was laid, and on this cribbing steel rails were placed to serve as a track on which the bridge could travel. Next, heavy I-beams were bolted to the pedestal stones of the bridge and, when these were jacked up, the heavy foundation stones beneath were broken up and removed. Then, beams and timbers were inserted under the pedestal cap stones in such a way that they rested on steel rollers designed to move along the track. This was done at each of 15 pairs of supports.

When all was ready, workmen were stationed at each support of the bridge to operate the jacks that would move it forward. Each time a whistle blew, each jack was moved five quarter turns. At two of the supports, the jacks fell out and yet the

work went on without them. Many people walked across the bridge as it was being moved.

When the structure had reached its new location, rollers and I-beams were replaced



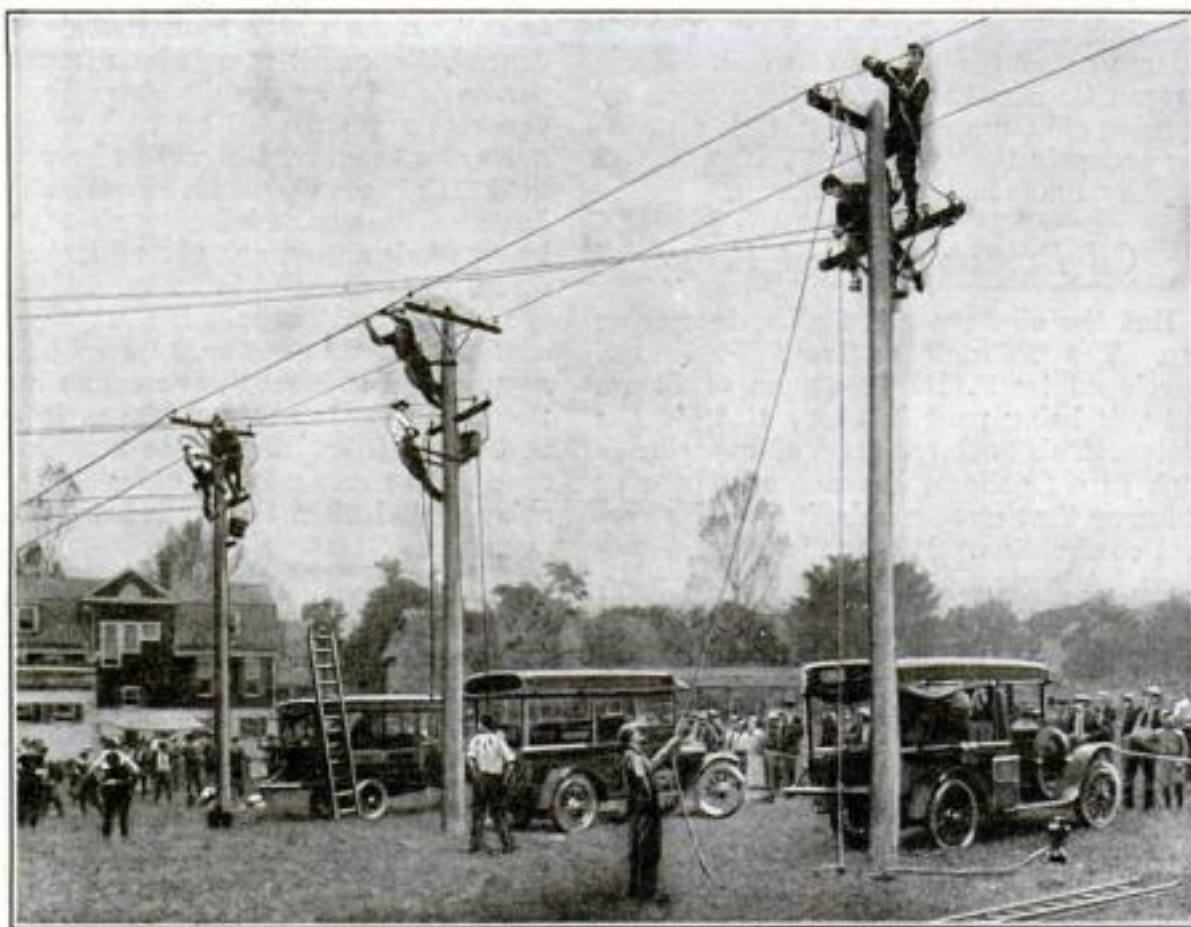
Above, a section of the 740-foot Jacks Run Bridge before it was moved side-wise 75 feet to its new location, as indicated by arrow. At left: How bridge supports, resting on rollers, were moved simultaneously along tracks. At a whistle signal, each jack was moved five quarter turns

by brick and concrete foundations for the original cap stones.

In just 26 hours after the actual moving started, trolley cars were running across the bridge in its new location.

An idea of the tremendous task involved may be gained from the fact that 100 truck-loads of equipment, 300 jack screws, 400 steel rollers, a mile of railroad rails, 150,000 feet of timber and 100 tons of steel I-beams were required.

Dazzling Speed Shown in Linemen's Race



THREE teams, each composed of two linemen and a helper, competed recently in a unique wiring efficiency test staged in Baltimore, Md.

Each team cut gains, or notches, in a pole, erected a cross-arm, hoisted a trans-

former into place, installed primary fuses, strung secondary wires from transformer to conduit, and connected, soldered, and taped all joints.

The winning team's time in completing the job was 15 minutes and 10 seconds.

Vitamine Products Tested and Found Wanting

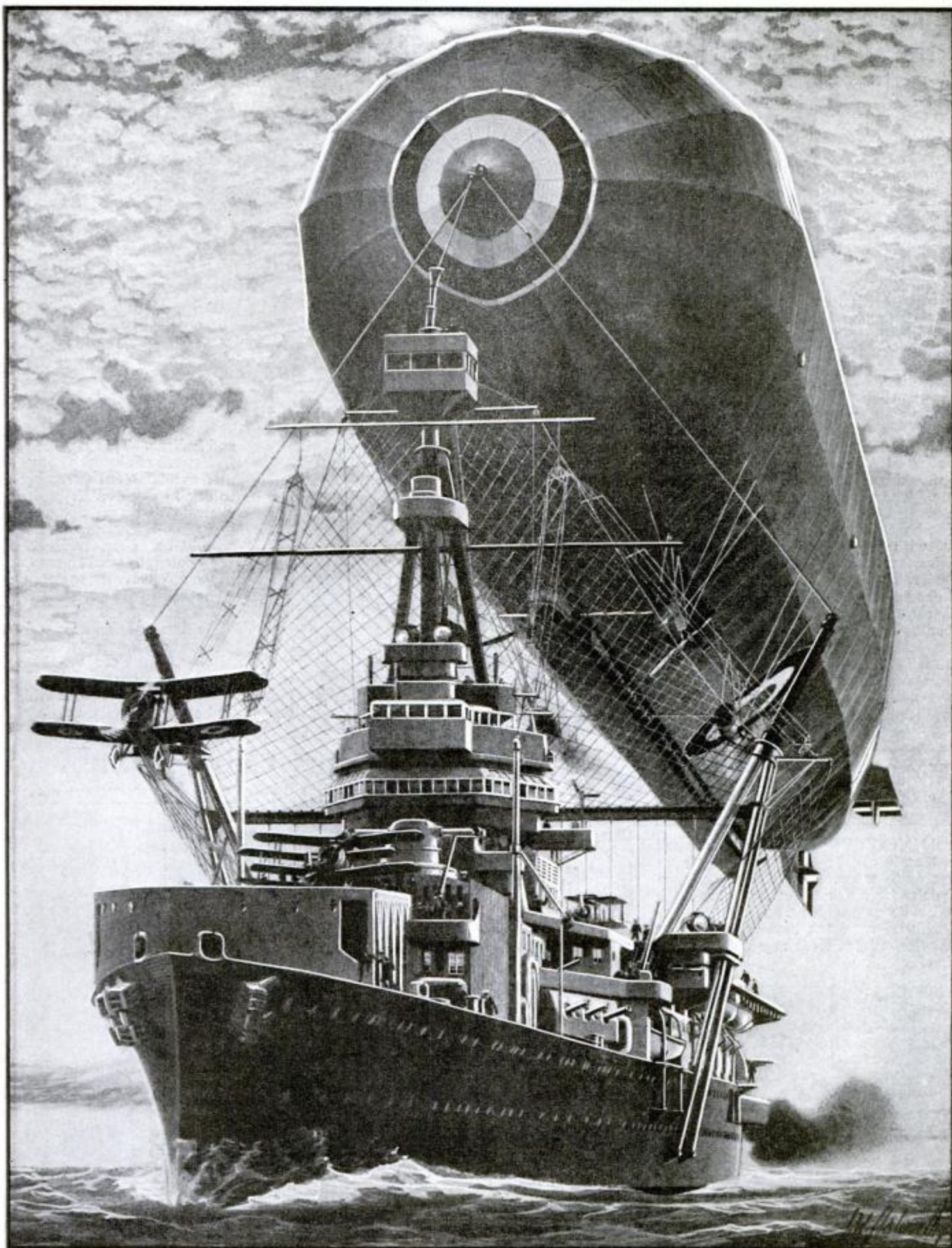
A THOROUGH investigation of special products claimed to be high in content of vitamins has been made by the Connecticut Agricultural Experiment Station with the result that of 25 samples examined, only two were found to be as effective as ordinary brewer's yeast.

The exact chemical nature of vitamins is, at present, somewhat speculative, but experiments tend to show that lack of these food factors causes serious undernutrition in the human body, as well as diseases.

In the recent investigations, rats were brought to a subnormal condition by being fed a diet lacking in vitamin B, and then were fed the products claimed to be high in vitamin content. For purposes of comparison, the same rats were fed ordinary brewer's yeast later. The rats showed a decided increase in weight after being fed the brewer's yeast, but failed in all but two cases to respond to the so-called vitamin products. It was even found in some cases that rats fed the commercial "vitamins" became ill of diseases caused by a lack of such vitamins. Two foreign and 22 domestic products were examined.

The Connecticut Experiment Station has suggested as a remedial measure that so-called "vitamine" products be considered as patent medicines and be made to conform to the same standards.

Floating Mooring Mast Proposed as Way Station for Airships



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CONVINCED that battle fleets of the future will require the aid of rigid airships as long range scouts, aeronautic experts recently have suggested an ingenious method of mooring rigids to the mast of a moving depot ship at sea, as pictured above.

The depot ship, preferably a converted

cruiser, has a hangar forward for small fighting planes, with a launching deck from which the planes are seen taking off to protect the rigid as it returns from a trip.

Topping a raised tripod mast is a mooring device to which the airship is anchored, while projecting from each side of the vessel are other tripods carrying guide ropes that

hold the airship's bow in position as its nose cone is hauled down to the mooring device.

Immediately behind the mooring mast is stretched a wire curtain to prevent planes from overrunning the great landing deck seen projecting above the boiler smoke ducts aft. Above this curtain is network to catch the mooring ropes when cast loose.

African Natives Carve "Mud Castles" for Homes



Over a domed framework of slender wooden poles the mud is plastered and dried in the sun

IN KIRDI-MASSA, on the west coast of Africa, you mustn't copy the design of another man's mud house. The offense is punishable by death.

The houses look like huge ant-hills, with only an inadequate opening for a door in the side and a small round chimney hole at the top to admit light and air. The design on the outside is often elaborate and worked out with the greatest pains, for it serves to identify the owner of the hut, and is virtually "copyrighted" by him.

The native builds his home of a stiff clay much like the adobe used by Mexicans



This design worked on an "anthill" house, serves as a family trade mark. To copy it means "vendetta" and death



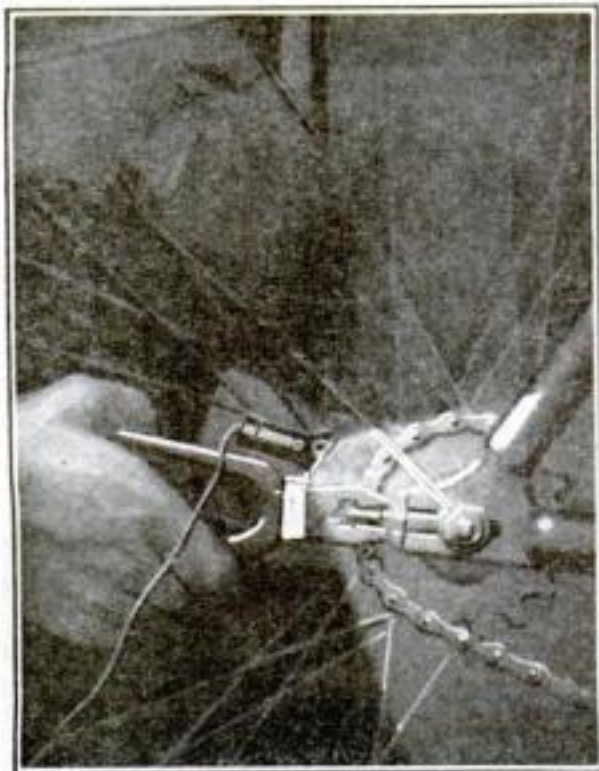
Kirdi-Massa natives outside their strange mud home. For ventilation, the low arched doorway faces prevailing winds

and Indians. This is poured over a framework of slender wooden poles used as reinforcements, and allowed to dry in the sun. The design is worked on with a crude trowel-like tool while the mud is moist.

The door, seldom large enough to admit a man standing erect, does not always reach to the ground. Since it usually faces the prevailing winds, causing a constant current of air to move through the hut, and since the thick mud walls keep out the heat of the sun, the interior is fairly cool, even during the terrifically hot summer months.

Midget Electric Lamp Is Clamped to any Tool

A MINIATURE flash lamp, so small that it can be clamped to the index finger or to a wrench, has been designed especially for use in tinkering around the automobile at night. The lamp is connected with a pocket battery, or it may derive its current from any electric light socket.



Clamped to wrench, this featherweight lamp throws light where needed

Lens Detects Bogus Coins in Subway

THE days when iron slugs and Chinese taels could safely operate the turnstiles of the New York subway is past, for the transit company has recently equipped the coin boxes controlling the turnstiles with lenses that magnify the coins to twice the size of a silver dollar. This makes it possible for inspectors to detect spurious coins at a distance of 15 feet from the machine.

When the transit company discovered that more than one per cent of the passengers were using all manner of cheap substitutes for the nickel, causing an annual loss of \$200,000, the mechanical detector was installed. Regularly appointed inspectors now closely watch the magnifying lenses.

When a nickel is dropped in the slot, releasing a catch that holds the turnstile, it is grasped by two arms that carry it into position in the rear of the lens. Light from an electric lamp is reflected upon the coin, illuminating it sufficiently to bring out the highly magnified details of the surface in bold relief, and thus expose any fake.



How coins are magnified and illuminated for inspection as they are dropped into turnstile coin boxes by subway passengers. Upper illustration shows how the detector reveals a Chinese coin. At right, five cent piece, showing Indian head design



Better Kitchen Methods for Modern Housewives

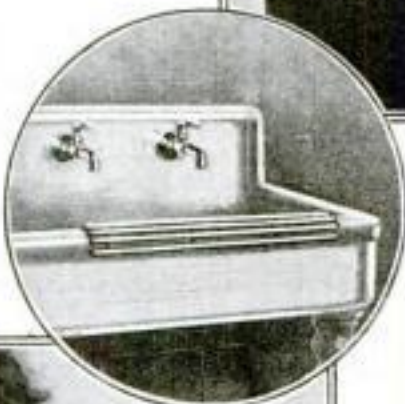


By using the mixer and automatic oil dropper shown above, French dressing to please the most fastidious palate is guaranteed, as the oil can be measured by the drop



Waxed paper can now be obtained in a box—containing 125 feet of paper—that is fitted with a sharp edge, enabling the easy cutting of whatever quantity is desired

To protect fine glass and china from hard porcelain, flexible boards of soft wood are designed to fit over sink edges, on drainboards, or on the sink bottom



For the sickroom, dining room, or kitchen, this door hook, replacing the usual knob, permits the busy woman to open the door easily when passing from room to room with both hands full. Pulling the hook turns the latch

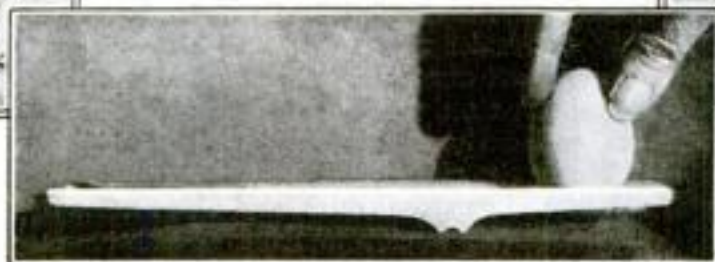


This switchlight glows as long as current flows through the electric iron. As a result, the housewife never neglects to turn the current off when her work is finished



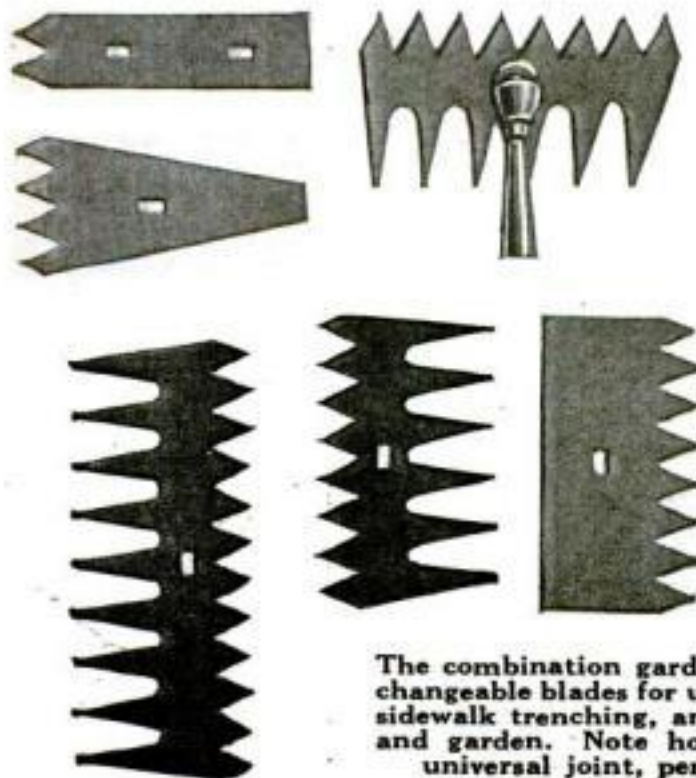
This rubber scraper will clean dishes, pots, and pans effectively, due to a surface that is resistant but not hard. It therefore will not scratch the article being cleaned

To determine just what grade of eggs your chickens are supplying, place large end of egg at right angles to the bar, and the scale will show whether egg is in the peewee, pullet, or standard class



Again electricity proves its value in the kitchen. The beating appliance illustrated above will mix cake batter, eggs, or cream more thoroughly than can the human arm

Combination Garden Tool Has Five Interchangeable Blades



The combination garden tool, showing five reversible and interchangeable blades for use in raking, hoeing, cultivating, weeding, sidewalk trenching, and a wide variety of jobs about the lawn and garden. Note how the blade is attached to handle by universal joint, permitting easiest adjustment of handle

A NEWLY invented garden and lawn tool with five reversible and interchangeable blades and combining 18 different cutting edges, may be used as garden rake, hoe, thinning tool, sidewalk trenching tool, weeder, hand cultivator, or soil pulverizer.

The universal ball-and-socket joint by which the various blades are attached to the handle, makes possible an adjustment of the handle in any direction up to 50 degrees from the vertical, considering the blade as a horizontal plane. The adjustment is accomplished by placing the foot on the blade, turning the handle one half turn to the left, thereby loosening the ball-and-socket joint and then, by turning the handle back to the right, fastening it.

Changing the blades is accomplished by removing one screw, placing in the desired blade and replacing the screw.

When used for cultivation, the sawtooth blades leave the surface soil in an exceptionally satisfactory condition.

How Uncle Sam Fights Menace of Dust Explosions

THE appalling loss of life and property resulting from half a dozen coal mine explosion disasters since the ending of the nation-wide coal strike last year has spurred Uncle Sam's officials to redouble their efforts to eliminate the hazard of dust explosion—a danger that continually confronts 21,000 industrial plants in the United States manufacturing products valued at nearly \$7,000,000,000 annually.

Where Dust Peril Lurks

This menace of inflammable dust, as dangerous as dynamite, powder, or gasoline, is present chiefly in coal mines, grain elevators, and flour mills.

In determining the exact causes of dust explosions in coal mines and discovering means of prevention, the government's most effective agency has been an experimental mine at Bruceton, Pa., where a series of 500 explosion tests have been conducted by the Bureau of Mines.

Until six recent mine explosions killed 185 workmen and injured 150 others, these experiments had succeeded in cutting down loss of life to a marked degree. A certain degree of laxity at the mines following the strike is given by the Bureau of Mines, as probable reasons for the sudden increase in disasters. Discussing these disasters, Dr. H. Foster Bain, director of the bureau, says:

"While one man may ignite firedamp by smoking or opening a safety lamp, or may cause an explosion by firing a dangerous shot, the broadcasting of these explosions through the mine is due invariably to the presence of coal dust. Such spreading of explosions by coal dust can be prevented."

The most spectacular of the government

"WE MUST regard dust, even the kind used to kill insects, as an explosive as dangerous as dynamite or gasoline."—David J. Price, United States Department of Agriculture.



To test the explosive quality of coal dust and gas, a cannon charged with an explosive is fired into a long, dust-filled steel tube. The photograph at left shows how the power of an explosion is tested by discharging a second cannon into a 31,600-pound mortar, which acts as a pendulum

its effects. If the explosive is to be classed as "permissible," the charge should not ignite the gas or the coal dust.

In a similar test the force of the cannon's explosion is directed against a huge pendulum weighing 31,600 pounds and consisting of the barrel of an old coast artillery mortar. The power of the explosive is determined by the swing of the pendulum.

As a means of preventing the spread of coal dust, the bureau advises either one of two methods: To wet the dust thoroughly so that no dry dust remains in the mine, or to dilute the coal dust with other non-inflammable dusts, such as shale or limestone.

SPARKS of static electricity, such as are caused by rubbing a cat's fur the wrong way or shuffling across a carpet on a dry, wintry day, may cause explosion accidents.

tests to determine what types of explosives may be safely employed in coal mines is produced by an ingenious apparatus, pictured on this page, which literally fires a charge of high explosive from a cannon into a long, dust-laden steel tube. This steel gallery, about six feet in diameter, is fitted with manholes at the top and observation windows at one side. On the inside walls are shelves on which coal dust is placed. One end of the pipe is closed.

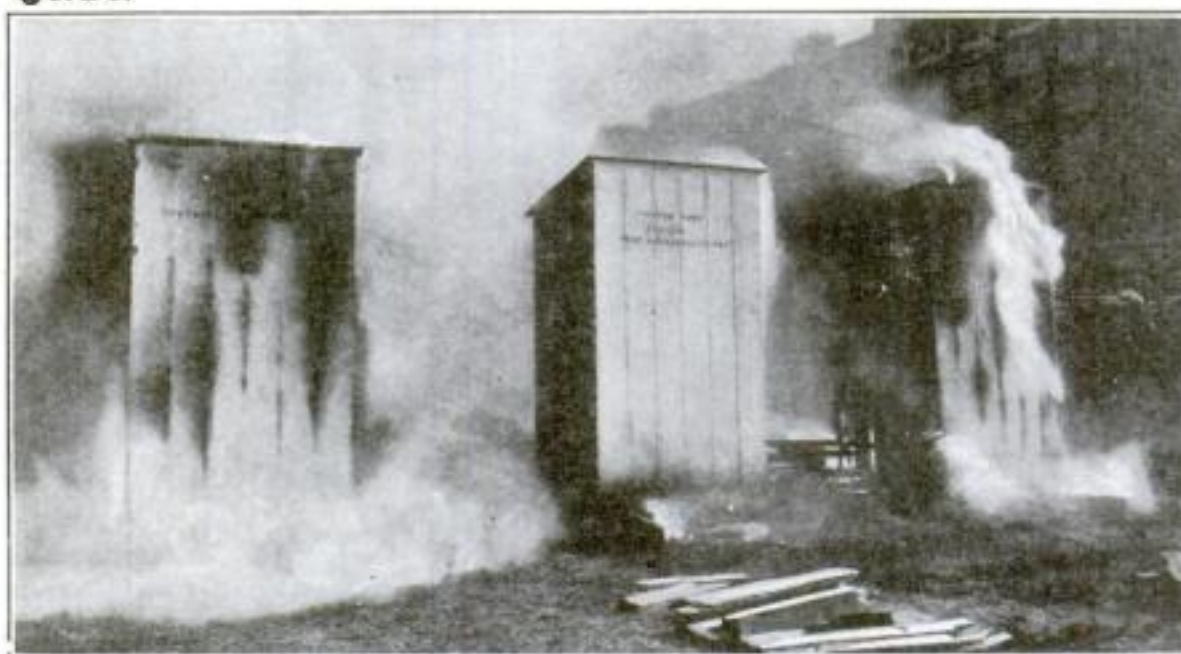
When the gallery has been filled with a mixture of gas, coal dust, and air at normal temperature, a charge from a cannon is fired into the gallery, while observers watch

Spectacular Test Proves Resistance of Fireproof Paint

© U. & U.

THAT paint can be prepared in such a way as to act as a fire resistant, protecting buildings to which it is applied, was demonstrated in a spectacular test recently conducted before the Fire Prevention Bureau of Chicago.

Three small buildings, constructed of ordinary inflammable pine, were placed 4½ feet apart directly facing a strong westerly wind. One was painted with the best grade interior mill white paint, another with a paint supposed to be fire resistant, and the third with a fireproof paint



Surrounded by burning shavings, the central building, coated with newly invented fire-resistive paint, remained standing after buildings at each side had been destroyed

recently perfected by a Western manufacturer. The buildings were surrounded with wood shavings saturated with gasoline.

Twenty minutes after the match was applied only the third building, coated with the new fireproof paint, was left standing.

There are a number of paints—easily prepared by the home owner—that add greatly to the fire-resisting qualities of a building. One cheap and effective method is to introduce powdered asbestos into the paint.

Famous Manager Predicts Egg-Shaped Playhouses

Plans to Paint Movie Theater Sets on Walls with Light



In the movie house of the near future, as pictured by S. L. Rothafel (at the right), a snow swept forest scene, projected in realistic colors on the white, egg-shaped walls of the auditorium as shown above, would provide a dramatic setting for a photoplay

THE day is coming soon when we shall not merely *look at* the movies; we shall *live in* them.

By scientific blending of color-light painting with action and music, by consummate artistic realism, we shall be transported to a vivid land of drama, where pulsating, colorful life springs from the very walls of the theater in which we sit. While the drama unfolds before us, we shall be encompassed by ever changing lifelike scenes—now the crashing waves of a sea; now the shadows of a great forest; now the towering buildings and the crowded streets of a city—projected in color on the walls about us.

We have this assurance from the managing director of the world's largest movie theater—from S. L. Rothafel, who already has carried into execution in the Capitol Theater of New York City some of his ideas for synchronizing light painting, music, and drama, which he prophesies will bring the motion picture art to a degree of realistic perfection surpassing the legitimate stage.

The theater in which these ideas will be fulfilled, as pictured by Rothafel, will have an egg-shaped auditorium with bare walls. He describes it as follows:

"Entering the theater, we are carried by escalators to an upper floor, where we find ourselves in a vast auditorium seating 5000 persons. Instead of elaborate architectural decorations, the walls of the egg-shaped auditorium are bare and white. But as the lights go down, we are suddenly flooded with colored light from a thousand re-

flectors cleverly hidden in the walls. Then, as a hidden orchestra plays, the walls that a moment ago appeared bare, become alive with changing panoramas—a forest, a sea, a great city—each in turn painted on the walls by colored light projectors above.

"While we are thus carried in our imagination to the land where our drama is to be enacted, the drama itself begins to unfold on the screen, the moving figures and the settings made real by lifelike colors and by stereoscopic perspective. Action, color, music, delicately blended and ever changing, melt our souls into the story on the screen, and we experience what the movies have been striving for ever since their first conception in crude form.

"My reasons for saying that the moving picture theater of the future will be an egg-shaped, balcony-less, bare-walled auditorium are various, ranging from the esthetic to the purely economical. In the first place, it is obvious that a theater of this shape will occupy the least valuable ground in the block—the 'core'; it will have a frontage of but a few feet; it will allow the entire lower floor to be used as a store. The audience will enter from the rear and leave by the front, saving endless confusion. The painting of walls with

changing scenes by light would not only mark an advance from a standpoint of beauty, but it would actually be an economy.

"Ten thousand scenes could be painted every year for far less than the decoration of the walls would cost. Light painting

He Began as a Failure

ONCE a failure at everything he attempted, S. L. Rothafel today is managing director of the world's greatest movie theater and ranks as one of the ten foremost motion picture geniuses of America—just because he learned how to make use of his own brilliant "visionary" ideas such as he presents on this page.

Rothafel began his movie career in a makeshift theater rigged up behind a barroom in a Pennsylvania mining town, renting his seats from the undertaker. There he conceived the idea of twilight projection of motion pictures to relieve the gloom of theater auditoriums. As a result, he was selected to manage a large theater in Milwaukee, Wis. Later he assumed charge of the Regent, Strand, Rivoli, Rialto, and finally the Capitol theaters in New York City.



Diagram of the proposed egg-shaped theatre, showing aisle-less seating arrangement and method of projecting scenic effects on the walls

would not be possible, of course, on flat, rectangular walls. In the matter of seating arrangements it will make possible a greater number of seats and more comfortable than a theater of any other shape could provide.

"All of these things may not be accomplished. But I can speak with surety when I say that most of them *undoubtedly* will be accomplished in the near future."

Fuel Oil from Coal

AS A method of supplementing the diminishing petroleum supply of the country, Charles R. Fettke, associate professor of geology at Carnegie Institute, proposes the low temperature carbonization of enormous quantities of bituminous coal now being burned for steam producing purposes.

He declares that the process will not only recover many valuable by-products, but will produce an oil fuel superior to that of raw coal and abate the smoke nuisance.

Photographic Road Map Shows Landmarks to Guide Tourists

THE problem of adequately guiding the automobile tourist traversing unfamiliar roads has been solved by the practical mind of E. C. Gamble, engineer, of Portland, Ore. With the aid of Portland business men, Gamble is producing an automobile guide book that includes not only a map showing accurately every mile of road of a given route, but also opposite the map, photographs of landmarks at intervals of every mile of the road.

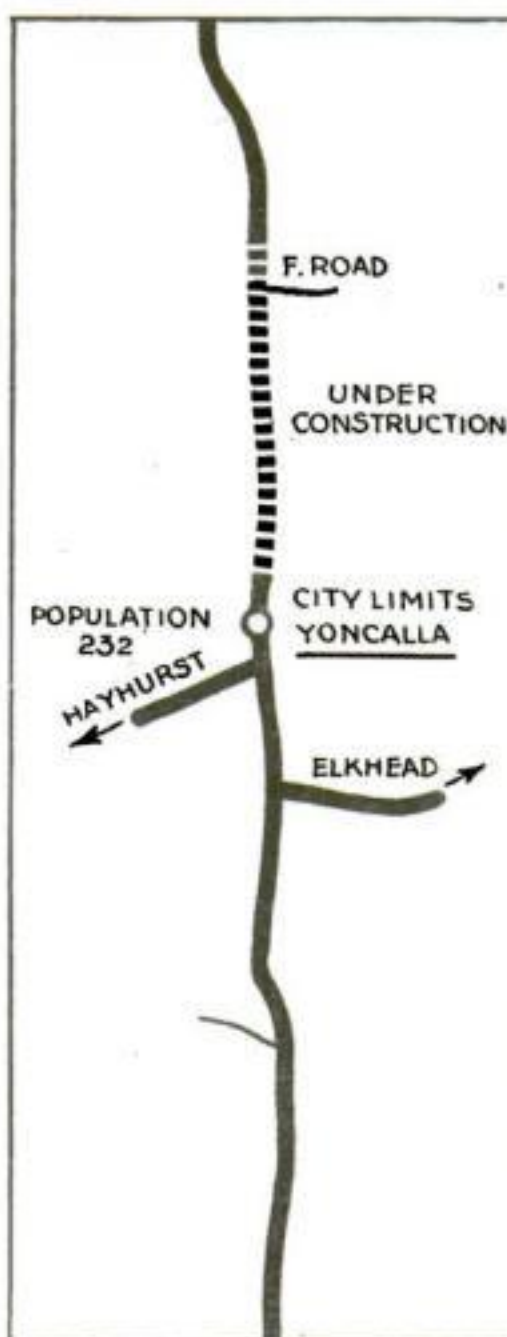
Gamble first tried out the plan in the state of Oregon, carefully mapping the roads and taking photographs at one-mile intervals. The pictorial road guide was so successful that he then began the tremendous task of mapping and photographing the road from New York to Portland. He has now completed this work and the pictorial road guide and chart map will be issued at an early date.

Supplementing the Map

Instead of using an ordinary road map, Gamble personally charted the entire distance, supplementing the chart of the road with explanatory notes such as "railroad," "bridge," "garage," "telephone," "view-point," and other information likely to be required by the tourist.

It is difficult for a motorist to get lost with this guide, for should he not find the bend, landmark, or scene pictured in his book at the end of each mile, he would immediately know he was on the wrong road.

The Editor will be glad to supply, wherever possible, names and addresses of manufacturers of devices mentioned in this issue.



This section of the new guide for automobilists shows map of an Oregon road at left, and opposite, photographs of landmarks along the road

Truck Searchlights Aid Fire Fighters

POWERFUL searchlights mounted on a special fire truck and playing on the walls of a burning factory building in Brooklyn, N. Y., recently aided firemen in fighting a terrific blaze and in rescuing dozens of men and women trapped in the upper floors.

The sweep of the flames was so rapid that escape from the upper floors was quickly cut off. Workers clung in terror to the fire escapes or flung themselves from windows. By the flood of light from two powerful lamps the firemen were guided in the work of rescue.



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New Shakeless Salt Cellar Works with Plunger

PLUGGED holes in the salt cellar need no longer ruin our dispositions since the invention of a shakeless salt container.

By pressing a plunger, a small valve underneath the container is unseated and a small amount of salt escapes. A spring returns plunger to place.



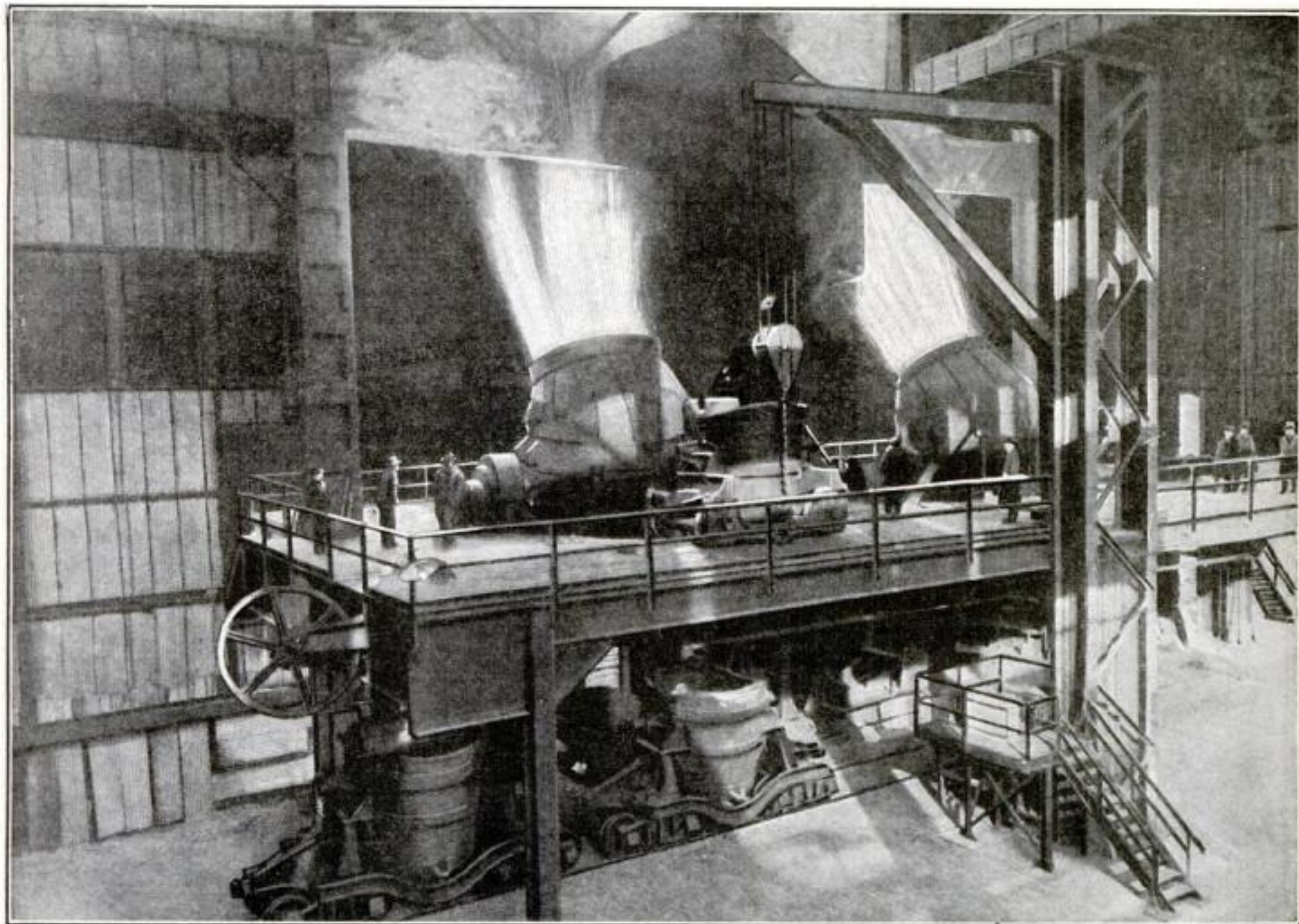
Pressure on the plunger releases salt from this little container

Quick Turn at High Speed Is Peril for Air Racer

PLANs for this year's Pulitzer Prize aero race brought out the fact that the human system cannot withstand the strain of a turn in the air in which centrifugal force is greater than four times gravity, because the heart is unable to force blood to the brain against this force.

According to Commander Jerome Hunsacker, naval flier, a violent turn of 90 degrees at a speed of 200 miles an hour causes a centrifugal force of about three times the force of gravity

Scientist Discovers Why Carbon Hardens Steel



In these huge flaming caldrons, known as Bessemer converters, molten pig iron is steel hardened by diffusing carbon in the correct proportions. Carried on cars from the smelter, the molten metal is poured into the cup-shaped vessels lined with clay and mounted on pivots. Here silicon, manganese, phosphorus, and carbon are removed from the metal and carbon

is later replaced. In the bottoms of the vessels are openings through which air is forced, after passing through the hollow pivots. Bubbling up through the molten metal, this air supplies the oxygen which unites with the undesirable chemicals, forming immense sprays of colored flaming gases that are blown out through openings in the top of the vessels

WHILE steel has been hardened industrially for many years by the introduction of carbon into the molten metal during the manufacturing process, the causes and nature of this phenomenon have been disputed questions until recently, when researches by Dr. Zay Jeffries and R. S. Archer, of Cleveland, Ohio, developed a theory that has enabled metallurgists to determine to a mathematical certainty what processes should be used in producing the desired degrees of hardness in steel.

The "slip interference" theory, as it is known professionally, holds that particles of steel, when under stress due to an external force, tend to flow or slide against each other along definite planes unless locked in place by particles of another element, carbon. When carbon is scattered through the metal, it forms innumerable little anchors that must be torn loose before the metal can slip. How these particles should be diffused in the metal to produce strength is explained in the accompanying diagram.

One of the methods of introducing carbon in the proper proportions is by means of the Bessemer converter, pictured at the top of the page.

By observing the color of the

flames emerging from the mouths of the converter caldrons, skilled workmen can determine the state of the liquid metal.

In obtaining the proper carbon content two methods are followed: One of these is

to stop the process when observation indicates approximately the correct carbon content. The second method is to burn out all the carbon and then recarburize the metal to the desired extent.

How Carbon "Balls" Lock Slipping Metal Crystals

THE diagram below illustrates Dr. Zay Jeffries' "slip interference" theory of hardening metal by the introduction of carbon. Assuming that the failure of metal takes place along slip planes when crystal particles of metal slip one over the other, consider a piece of steel as a lot of iron plates piled on top of a magnet, as shown in each figure below.

Figure 1 represents unhardened metal. Here it is difficult to pull the plates directly away from the magnet,

but it is easy to slide them off sideways. When the strain on the metal is too great, the crystals slide away until a break occurs.

Figure 2 illustrates the diffusion of carbon particles through the metal, like a lot of balls inserted within the plates, so that each ball keys several plates and prevents them from slipping. This represents properly hardened metal. If the carbon balls gather in a large mass, as in Fig. 3, only part of the plates or metal crystals is keyed from slipping, and the strength of the metal is lessened.



Dr. Zay Jeffries, originator of the "slip interference" theory



Fig. 1

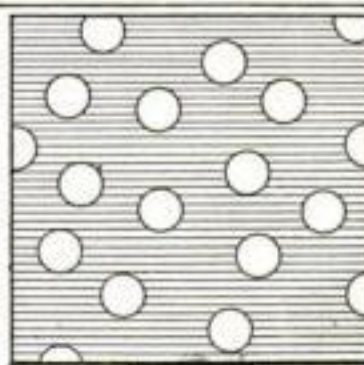


Fig. 2

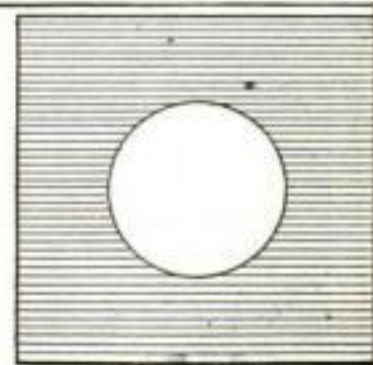
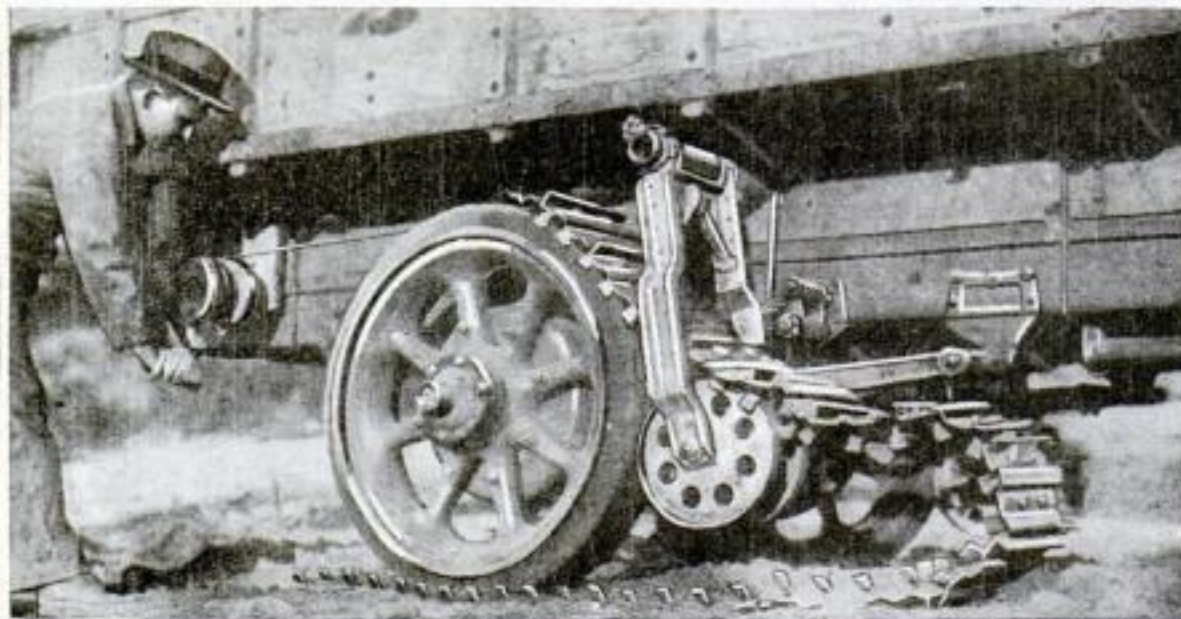
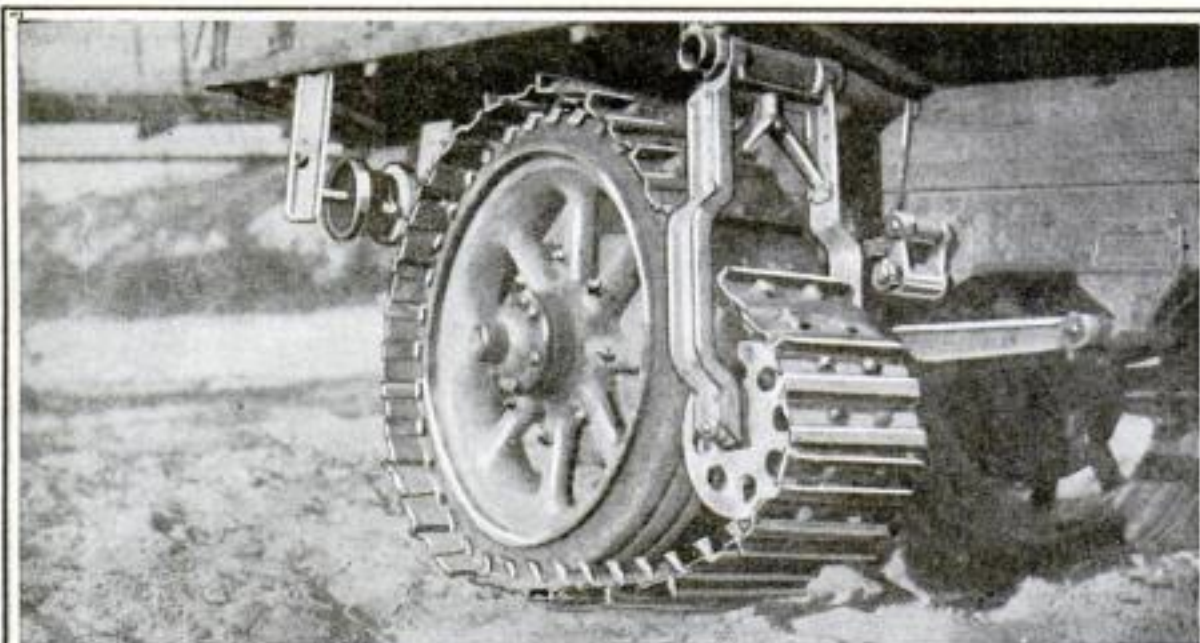


Fig. 3

Endless Track Fits over Truck Wheels



Courtesy the Commercial Vehicle

Top: Complete track unit in position. Note position of idler, swinging against wheel. Center: Pulling track over wheel and idler. Bottom: Track rolled up and idler swung out of the way

A REMOVABLE continuous tread track that may be adjusted to any standard motor truck in 10 minutes for operation over soft ground, has been invented by C. F. Ball, of Santa Ana, Calif. When not in use, the track is swung high up under the truck and out of the way.

The track is similar to that used on endless tread tractors, and is equipped with a device for joining the ends when in operation. An intermediate idler, mounted adjustably on a crank arm and running against the truck tire, holds the track in a position to insure proper tension.

A crank reel mounted on the truck back of the rear wheel serves not only as a hanger to hold the track when not in use, but also as a pulley in adjusting the track over the wheel and idler. The idler, when not in use, also swings out of the way under the truck.

The drive is by friction from the tire, producing a maximum speed of 20 miles an hour.

Safety Sign Rights Itself if Knocked Over

ALTHOUGH a careless driver might knock over one of the safety signs used about a factory at Moline, Ill., the danger spot will not remain unmarked, for the sign is provided with a heavy cup shaped base that will draw the sign into its erect position if thrown over on its side.



Locknut Auto Advertises Shock Absorbers

SHOCK absorbers for a light car have been successfully advertised by building the body of a car in the form of a huge locknut. The idea that the firm seeks to



The body forms a huge locknut

put across is that its improved shock absorber reduces vibration and prevents the nuts on the car from being shaken off.

Electric lights on the corners of the body illuminate the advertising matter painted on the sides, and projecting wooden hands direct the attention to the shock absorbers.

THE Editor will be glad to supply, wherever possible, the names and addresses of manufacturers of devices mentioned in POPULAR SCIENCE MONTHLY.

Autos Parked on Roof of Building



This parking station on a Seattle office building accommodates 100 cars

Do You Know How to Overhaul Your Car for Summer Touring?

Auto Expert Tells Fine Points of Spring Housecleaning

By Harold F. Blanchard

HAVE you done your spring automobile overhauling?

Perhaps not yet. But if you value your car, if time means money and pleasure to you, and if you wish to be saved needless expense, you must certainly plan a complete overhauling, just as the housewife plans her spring house cleaning. If you are an average motorist, your car receives the very hardest kind of service during the winter, when it pounds over roads roughened with mud, ice, and snow, and when the mechanism is continually exposed to the ravages of cold and moisture.

Be Your Own Car Doctor

You are probably looking forward to several thousand miles of motoring (for business or pleasure) this year. If so, and if you think of your car as a loyal friend, you will plan to give it the advantage of a thorough going over in order to repair the damage winter has done and put the car in tune for summer.

But do you know how to inspect your own car? Do you know just how to overhaul it, tune it, and make the whole an harmonious piece of mechanism? If you are an average motorist, probably you do not; and so I am going to outline in detail here the important steps necessary to put your car in condition for summer, just as I explained last fall what should be done when winter comes.

First, let's see how winter affects your automobile. What parts are most exposed to effects of icy blasts and rough usage?

The answer is easy—Springs. Tires. Batteries.

By far the most important item in overhauling your car is to find out whether there are any broken or cracked leaves in your springs. Wash off the sides of the springs with kerosene and examine each leaf for its full length. Like a small cut in a tire, a single broken leaf is a weak spot that must be watched; for one broken leaf means that other leaves in the spring will eventually break.

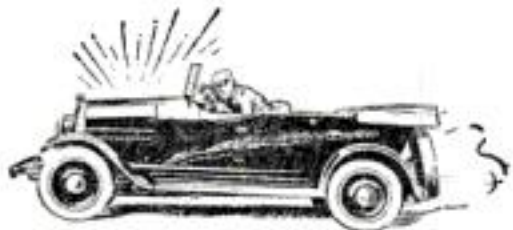
Watch Out for Tire Cuts

The next step is to examine the tires for cuts. If you find any of importance, fill them with tire compound. Large cuts should be vulcanized.


Third, have your battery examined by an expert. If you have been running your car infrequently, the chances are that the battery is run down and perhaps also sulphated. If you have been calling on your car for much use, the battery may have been damaged by overcharging on long drives. In any case, it will pay you to see that it is in good shape before you start your summer motoring.

You can never count on a battery. Some batteries will last for years. Others will give out in a few months. I know one motorist who bought a new battery last spring. During the summer months he covered several thousand miles alternating between long and short trips. In the late


The "Fourteen Points" of Car Testing



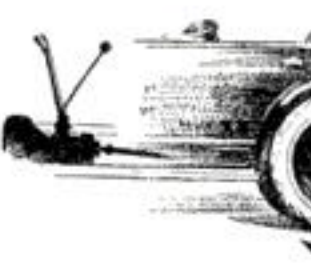
1—Drive car to determine whether valves must be ground and carbon removed. If car has a tendency to knock when throttle is opened, and the noise is not due to spark being advanced too far, then carbon removal is probably required. A carbon knock and a spark knock are similar in sound




2—If the engine lacks power and runs irregularly, especially at low speed, the valves may need grinding. To make sure, crank the engine over slowly by hand with all petcocks open, except on the cylinder being tested. If some or all cylinders show poor compression, valve grinding is required




3—Examine tires for cuts. Deep cuts should be vulcanized and lesser ones filled with tread repair compound



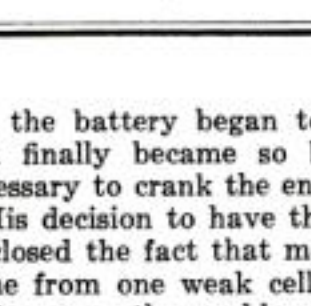
4—Clean and adjust spark plugs



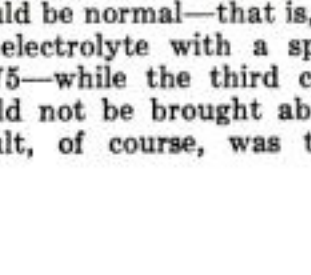
5—Test specific gravity of each battery cell. Cells in good condition should read from 1.280 to 1.300; those below 1.200 are discharged or defective



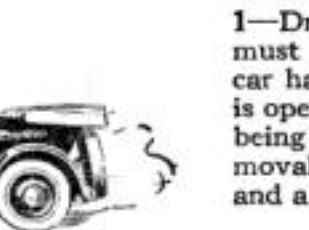
6—Loose connecting rod bearing is usually indicated by hammering when engine is decelerated or when idling. Loose main bearing pounds most with wide throttle



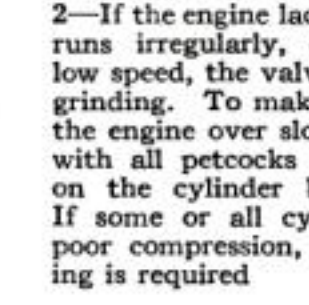
7—Examine starter and generator brushes for wear and commutator for smoothness



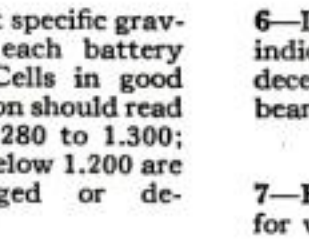
8—Determine play in drive mechanism by placing lever in high gear and jacking up one rear wheel. If play measured on the wheel rim is more than an inch, call on competent repairman



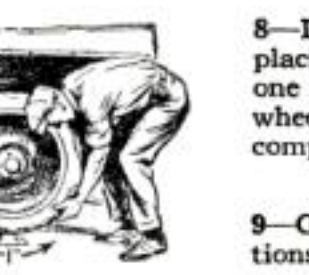
9—Go over all wiring, tightening connections, and replacing badly insulated wires



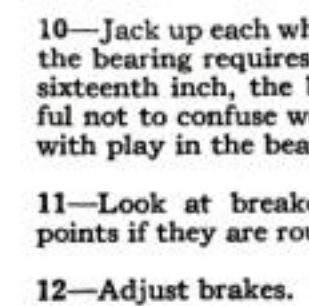
10—Jack up each wheel and shake it to determine whether the bearing requires adjusting. If play is more than one sixteenth inch, the bearing should be adjusted. Be careful not to confuse wear in the kingpins of the front wheels with play in the bearings



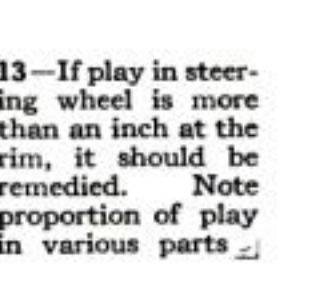
11—Look at breaker mechanism. Smooth and adjust points if they are rough or pitted



12—Adjust brakes. Reline if lining is worn out



13—If play in steering wheel is more than an inch at the rim, it should be remedied. Note proportion of play in various parts



14—Check tightness of fan belt, also tightness of hose connections, and pump glands

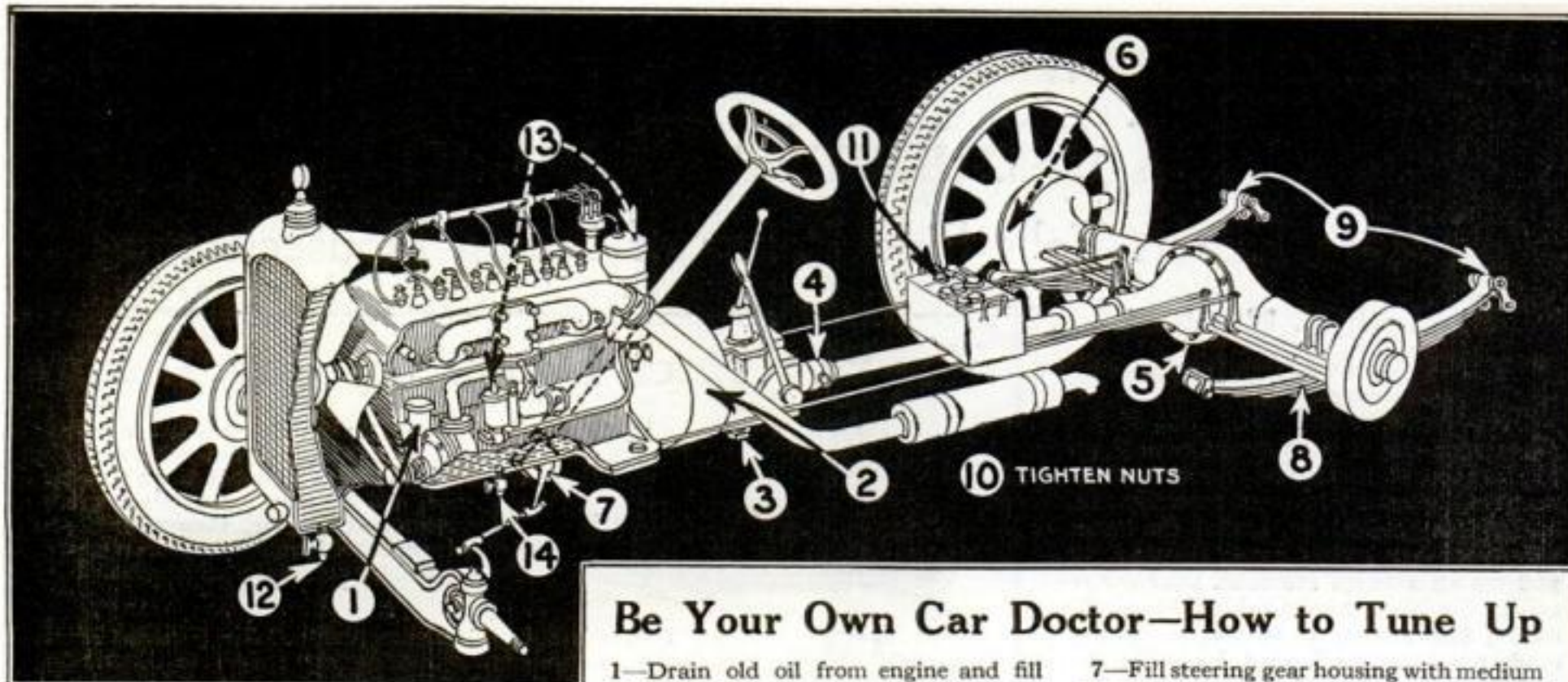
fall the battery began to show weakness and finally became so bad that it was necessary to crank the engine by hand.

His decision to have the battery rebuilt disclosed the fact that most of his trouble came from one weak cell. Whenever the battery was thoroughly charged, two cells would be normal—that is, they would have an electrolyte with a specific gravity of 1.275—while the third cell was weak (it could not be brought above 1.150). The result, of course, was that the battery

quickly lost its charge. It would crank the engine a few times after charging, but soon was as bad as before.

"What caused the weak cell?" you may ask.

This time the answer is easy. Lack of water and overcharging did it. During the early spring, neglect to add water to the cells caused the electrolyte to fall far below the plate tops and the front cell was particularly dry. This condition was aggravated by overcharging on long drives.



Be Your Own Car Doctor—How to Tune Up

- 1—Drain old oil from engine and fill with new oil.
- 2—Wash clutch surfaces with kerosene if they are dirty, using oil gun.
- 3—Drain oil from transmission by removing plug; flush with kerosene, and fill one third full with heavy oil.
- 4—Fill universals with soft grease.
- 5—Drain oil from rear axle; flush with kerosene and fill one quarter full with heavy oil.
- 6—Remove hub caps and fill with medium grease.

- 7—Fill steering gear housing with medium grease.
- 8—Lubricate springs if desired.
- 9—Fill grease cups and oil holes.
- 10—Tighten all nuts on car. Do this systematically so that none is overlooked.
- 11—Add water to storage battery.
- 12—Drain radiator and refill.
- 13—Clean sediment from carburetor, strainer, and small strainer in vacuum tank intake.
- 14—Remove strainer from engine lubricating system and clean with kerosene.

After a battery has become fully charged with continued driving, any additional current sent through it merely heats the plates with a liberation of gas and steam. This action, in turn, blows the active material off the plates, stripping the cell of its wherewithal to do business. If the cell is full of electrolyte, the full area of the plates is in circuit and the effect of the overcharging current is spread out to a maximum degree. But if the cell is just half full of electrolyte, only the lower halves of the plates are in circuit and the overcharging effect is doubled.

Add Water to Battery Weekly

The remedy for such a condition is to add water at least once a week during the summer. If no water is needed one week, examine the battery the following week just the same. The second point for you to remember is to run with the headlights on whenever the battery is charged. The state of charge can be roughly determined by the pitch of the horn.

There are many recognized methods of examining a car preparatory to general spring repair work, but I have found the 14 points illustrated on the previous page to be the most effective.

Tighten All Nuts

Whether or not these tests show any faults in your car, there are a few small jobs that should never be neglected. The outstanding of these is to give the car a general tightening up. No nut, pin, screw, bolt, or stud of any importance should be overlooked. Let me recount a few of my experiences:

Last summer I was following another car along a country road when I saw the front end of its propeller shaft drop. Before the car could be stopped, the shaft caught on a large outcropping of stone that bent the shaft and gave the axle a wrench that broke a spring. Examination proved that this was clearly a case of neglect to tighten nuts.

Another driver stripped the starter teeth on the flywheel because the nuts holding the starter had loosened up enough to permit the starter to slip somewhat out of mesh so that the flywheel teeth and the pinion teeth just meshed at the tip.

A friend of mine, owner of a large six-cylinder car, had the unpleasant experience of rear axle and wheels parting company

with the rest of the car while running between 35 and 40 miles an hour. I might go on almost indefinitely recounting instances of trouble and damage caused by failure to tighten parts.

Just remember that when an automobile is running, every little part on it is vibrating. In time vibration will loosen any nut unless secured by a good locknut, and it will wear away most cotter pins. That's why it is so necessary to tighten every nut, pin, bolt, and screw that you can reach. Electric connections especially should be gone over frequently. If they are kept tight and electric wires kept from chafing, you will have very little electric trouble. Remember that a wire that chafes against anything is a potential short circuit.

Remember the Radiator

One of the left-overs from winter is the anti-freezing liquid in the radiator. Not only should you drain the compound from the radiator, but you should flush the system with a solution of washing soda and water, using a pound to a gallon, and run the car for two or three days before draining it off and filling with clean water.

Some gasoline also should be drained from the carburetor to remove any dirt lodged in it. The little wire filter screen at the point where the gasoline enters the vacuum tube should be removed and cleaned. And certainly the carburetor should be adjusted for warm weather.

To insure proper lubrication, drain the old oil from the engine and replace with new oil,

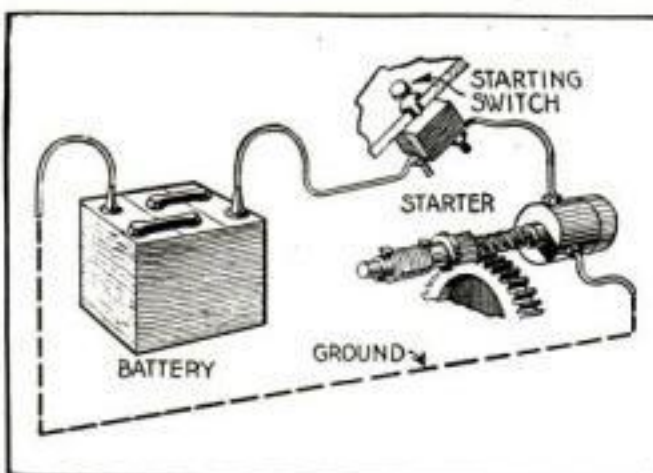
Know Your Car

Your Starter

THE starter circuit is as simple as a house bell circuit. The current is supplied by the storage battery through a heavy cable, the circuit being closed by the starter switch. Instead of a return wire from starter to battery, the return current flows through the car frame, one terminal of both battery and starter being grounded.

On most cars the pinion on the starter motor meshes with teeth cut in the flywheel, while the starter shaft on which the pinion is mounted is spirally cut. When the starter pedal is depressed, the starter motor begins to spin and thus screws the pinion gear (which is automatically prevented from rotating) out to the end of the shaft and into mesh with teeth on the flywheel. As soon as engine starts, the flywheel runs faster, screwing the pinion back out of mesh.

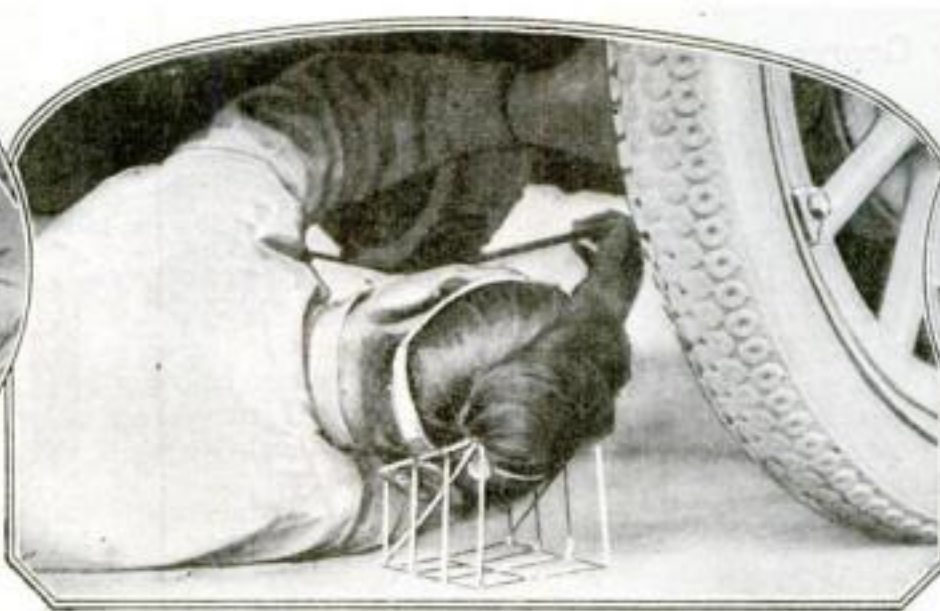
Ordinary starting troubles are weak battery, short circuit in cable or starter switch, dirty switch, loose connections, brushes worn, or commutator dirty. Dirt or gummed oil on the starter shaft may prevent the pinion from meshing.



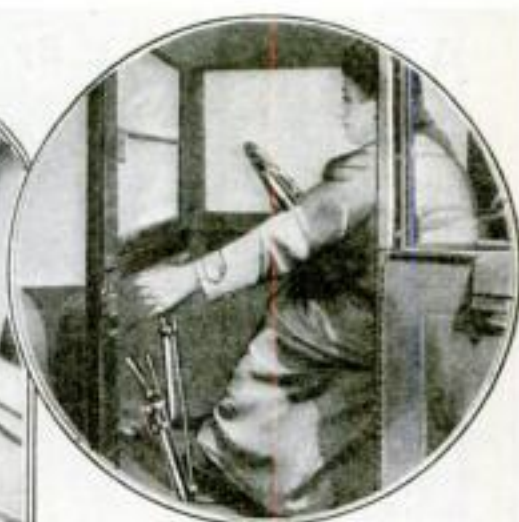
New Accessories that Add Pleasure to Motoring



This four-in-one wrench can be adjusted to fit any standard rim bolt



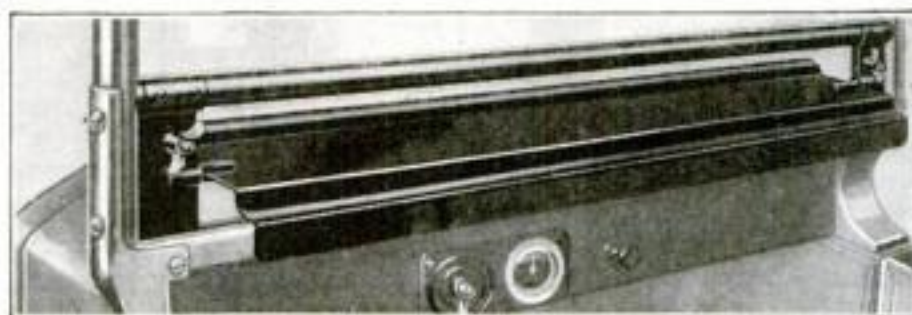
An auto-mechanic's headrest has a U-shaped yieldable frame and head pad. A strap holds it to the user's forehead



A clever extension handle (above) fits on the regular Ford brake lever, eliminating the troublesome long reach for the emergency brake



The two gaskets required in the ordinary spark plug are eliminated in a two-piece plug, shown at left, the porcelain insulator and upper part of shell being in one

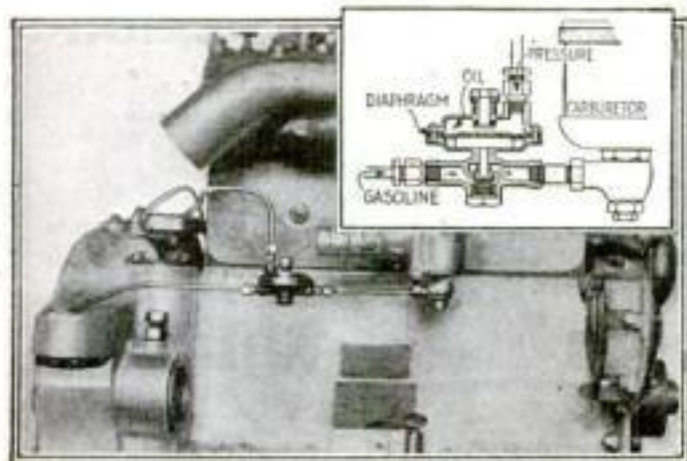


A new ventilator for Fords (above, at right) does away with direct draft on face and head, protects coilbox, and can be locked in any position

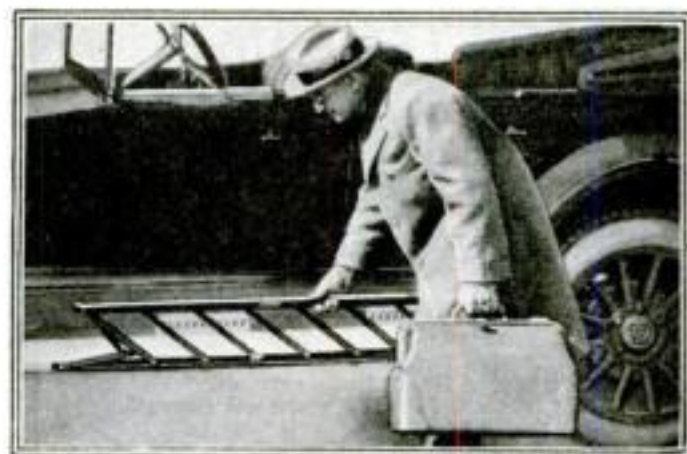
The "low gasoline" alarm shown at right is designed to screw into the filler opening of the tank. It contains a bell that rings when the gasoline supply is low



An unusual eye shield of clear celluloid (at left) has V-shaped cut to fit the nose. A flat spring device slips on the cap holding the shield in position



A new safeguard against engine damage is a diaphragm that shuts off the gasoline supply when the oil supply fails



This new luggage carrier folds ingeniously at the outer edge of the runningboard, where it is bolted, snapping open for use

but do not flush the engine with kerosene. This is the logical time to remove the oil filter screen and clean it.

Transmissions usually give little trouble, but every one of them should be drained of the old oil, flushed with kerosene, and receive a supply of new oil. The same applies to the rear axle. The universal should be filled full of a medium grease—a process that should be repeated every 2000 or 3000 miles. Wheel bearings and steering gears also should be filled with a medium grease. Every grease cup and every oil cup should be given its full quota of lubricant.

Clean All Ignition Parts

Ignition parts should be cleaned and adjusted. This means particularly that the breaker points should be examined, filed, and adjusted if required. The distributor should be wiped clean and the spark plugs should be removed and cleaned unless it is your practice to do this work whenever valves are ground.

If your car has been laid up, it may be that the pistons have rusted to the cylinder walls and the engine cannot be turned over. Usually the pistons may be loosened by flooding with kerosene and allowing to stand. But in some cases it is necessary to dismantle the engine in order to free the pistons.

You may have been unfortunate enough to have had your radiator freeze during the winter. If the radiator leaks badly, it may be cheaper to throw it away than to attempt to repair it, although a radiator compound is frequently effective. If the tubes are cracked, the remedy depends on conditions.

Almost any motorist is competent to do the simpler jobs I have outlined. But I do not advise an inexperienced man to adjust engine bearings and rear axle bearings. Valve grinding is a job that almost any man used to handling tools can do, but my experience is that the amateur's job is not always successful.

There is one final point I want to emphasize. Not long ago a car was brought

to me which backfired so badly that it would hardly run. Muffler explosions were occurring regularly. The owner said that he had just spent an entire Sunday grinding the valves. I found the valve adjustment perfect but the valve stems proved to be a trifle loose in their guides. I told him that the trouble could be nothing but shoulders on the valve faces—shoulders that he had created by grinding. To cure the trouble, the cylinder head had to be removed, the valves refaced, and the seats trued up. The shoulders on the valves were very slight, but they were enough to produce a very badly running engine.

Shoulders Should Be Removed

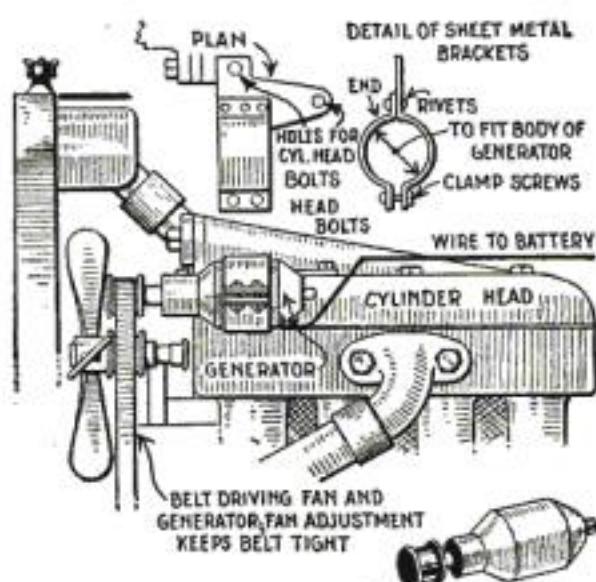
The point here is that the motorist who otherwise does a perfect valve grinding job runs the risk of failure unless he removes the shoulders on the valve faces, and he needs experience to judge this point. Removing shoulders is a slow process unless special equipment is available.

Auto Generator Is Easy to Install

By George A. Luers

AN **ELEC-**TRIC generator for recharging a storage battery on automobiles not so equipped, can be easily installed by the car owner at small cost and without any radical alterations to his engine. The advantages of such an installation are obvious: It permits the use of electric light and provides a separate source of current for the ignition as well as current for an electric horn, cigar lighter, and any other attachments that may appeal to the owner.

One car owner who added a generator was sufficiently experienced in electric work to rewind the motor of a small fan so that it would serve as a generator. If it is not desired to do this, a small generator can be obtained second hand at a moderate cost from a dealer in wrecked and dismantled cars.



A SMALL GENERATOR OR A CONVERTED FAN MOTOR IS FITTED WITH A SMALL FLANGED FAN PULLEY

The fact that one belt drives both fan and generator makes this a simple installation

The generator is attached to the car, as shown, by a strap that encircles the generator and is held by the cylinder head bolts. The strap is of heavy gage sheet iron and need not be particularly rugged, as the belt drive does not place much strain on it.

A pulley is fixed to the shaft of the generator so as to come directly in line with the fan pulley. The drive is obtained by increasing the length of the fan

belt and running it jointly over the fan and generator pulleys. The fan pulley adjustment is used to obtain the belt tension required.

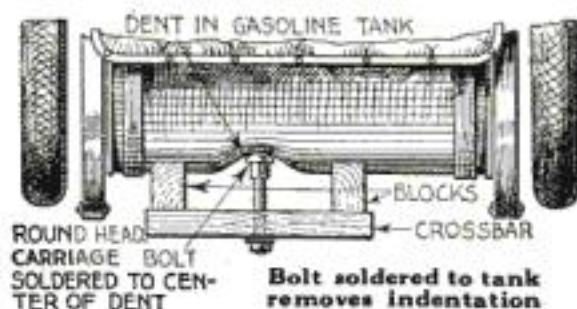
This method of attachment and driving will apply to practically any engine.

If the generator is in good condition and the belt adjustment correct, the device will prove practically foolproof.

Bolt and Wooden Blocks Repair Dented Gas Tank

IF EVER the gasoline tank of your car becomes dented, the tank may be repaired simply in this manner:

The first step is to fill the tank with water and drain it, to avoid any possibility of a gasoline explosion when solder is applied. A round end carriage bolt is then



soldered firmly to the center of the dinged portion of the tank. A crossbar with two blocks is fitted over the dent so that the threaded end of the bolt passes through it. By means of a nut and washer on the bolt sufficient pressure can be exerted on the depression to draw it out flush.

If a hole was made by the collision, the same method may be used and the opening filled with the solder left after the bolt is removed.—M. T.

IN WASHING your car, guard against using too much soap, gasoline, or any cleanser intended to cut grease. If allowed to remain too long on the finished surfaces, they are apt to damage the varnish.—H. K.

Brass Paper Fasteners Will Replace Lost Oil Taps

OIL taps or oil hole covers in the chassis of an automobile have a tendency to work out and become lost on the road. As a temporary substitute that will prevent grit and dirt working into the bearings, paper fasteners can be used by doubling the ends in and forcing them into the screw holes. This covers the opening fairly well and is easily removable. This method serves for either drilled or threaded holes.—F. B.



This Detachable Windshield Cleaner Is Quickly Made

AFTER barely avoiding a head-on collision because of a wet windshield, I was presented with the windshield cleaner illustrated, by a mechanic who made it on the spot. He used two 10-in. lengths of rubber tubing placed over the ends of a 3-ft. length of stiff 1/8-in. brass wire, bent as shown, so that the rubbers were about 4 in. apart.

While not an enameled and polished article, the cleaner serves its purpose satisfactorily, is easily detachable, and can be replaced at very little expense when lost.—F. L. G.



Building Your Own Gasoline Station

By Fred T. Anderson

GASOLINE can be obtained at the wholesale price only when a storage tank of 50 gals. capacity is available. With such a tank it is possible to buy directly from dealers at a cost usually about three cents a gallon less than the retail price. When a tank of this size, with the necessary fittings, is purchased, the cost is so great, however, that it uses up the saving in cost that will be made later. But a tank that will serve every purpose can be constructed cheaply.

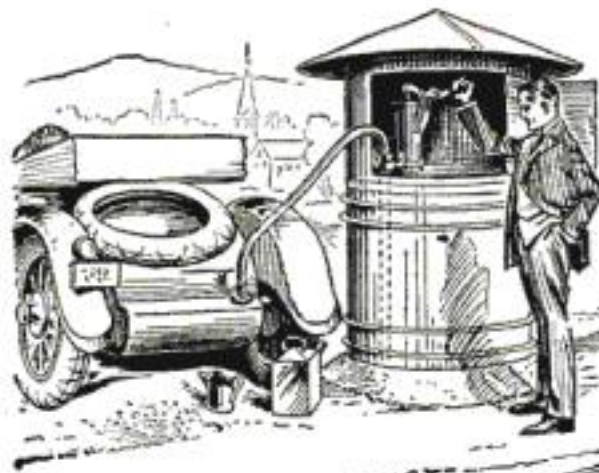
The one illustrated can be built for about \$10, including tank, pump, hose, and casing. A 50- or 55-gal. oil drum, which can be bought second hand for from \$1 up, forms the tank. This is up-ended and a small retaining ridge of concrete put around it to hold it in place.

A cylindrical upper section with a conical cover is made from galvanized

iron, riveted to the upper flange of the drum, which is provided with a hasp and padlock. A section of this upper casing is cut out and hinged to form a door. There is space in the hood for several gallons of lubricating oil.

The pump is of the type used for inflating tires, and it is used to force the gasoline from the tank by increasing the air pressure within it. The hose connects with a pipe line set into the tank with the lower end an inch or two above the bottom. The filling cap is fitted with a gasket to prevent any leakage of air.

Several modifications of this method are possible, one of the best of which is to bury the tank outside the garage and run pipes for air and gas into a convenient corner of the garage. The problem can be adjusted to each individual requirement.



An old oil drum serves as a tank for this home garage filling station

Tacks Repair Broken Fan Belt

TACKS pulled from a roadside sign will often enable you to "rivet" the ends of a broken fan belt together. The adjustment probably will have to be loosened before the work is started. Then take a half dozen tacks, preferably ones with large

heads, and force them through the two pieces of the belt with a pair of pliers. Place the heads on the inside and clinch over the points.

If the belt is so arranged that there is not sufficient slack to place it on a solid surface, the upper pulley may be used as an anvil.—K. L. R.



The Home Workshop

New and Useful Things to Make with Tools

How to Make a Vacuum Tube Set for \$20

By Joseph Calcaterra

WITH the advent of the dry-cell vacuum tube, which requires no storage battery, it is possible to make a regenerative receiving set for \$20 or less. That is but slightly more than the cost of a crystal set. This type of radio set, however, has a distance range of from three to five times that of a crystal set. Concerts up to a distance of about 100 miles can be heard.

For those who already have crystal detector sets using a variocoupler as a tuning element, it is necessary merely to add a dry cell tube and socket, a grid condenser with leak, a rheostat, a 22½-volt B battery, and a 1½-volt dry cell of the type used to ring house bells.

While this sounds like a long list of extra parts, all can be bought at practically any radio store for seven or eight dollars.

Those who do not have a crystal set will have to get a standard variocoupler, a small panel about 3 by 6 in., two inductance switches, an instrument dial, 14 switch contact points, four binding posts or contact clips, 10 or 15 feet of annunciator wire, and a dozen ¼-in. No. 6 brass wood screws or other screws about that size. The total cost will not amount to more than \$4.50.

The other supplies necessary for a complete set are the aerial equipment, consisting of from 100 to 150 ft. of aerial wire, two aerial insulators, a lead-in insulator, and a lightning arrester. This equipment should cost not more than \$3.

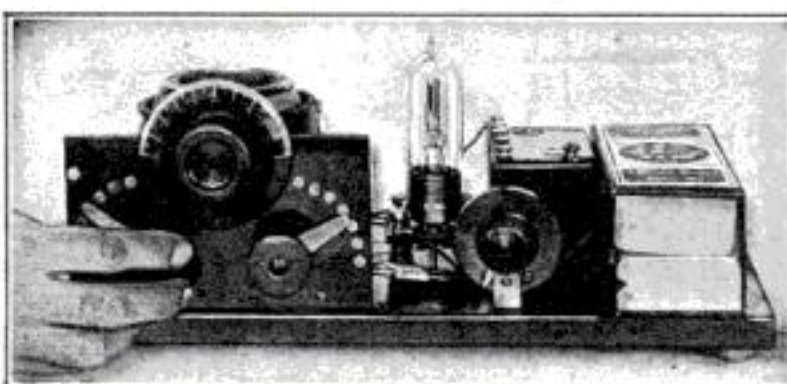
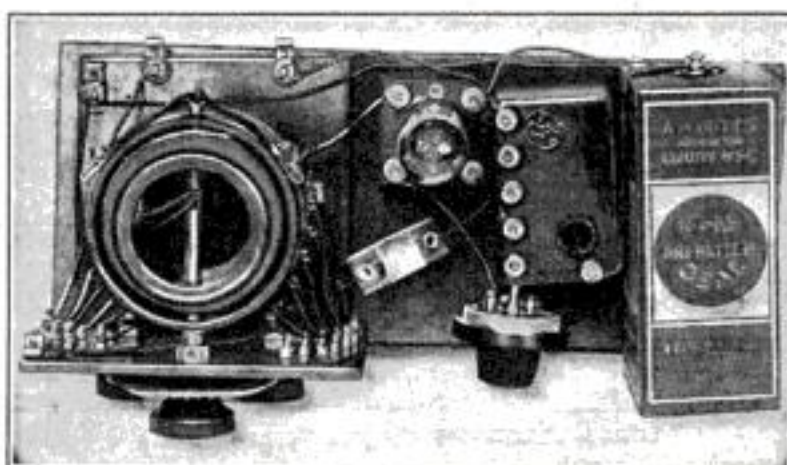
Taking the cost of each part of the set at the highest figure, about \$5 is left for the phones, which is sufficient to buy a very satisfactory head set.

These figures are based on assembling a set from commercial parts. Any one who is handy with tools can make a variocoupler for about 50 cents. Brass screws can be pressed into service as switch points, thereby saving another 40 or 50 cents. A condenser can be made at home and even a vacuum tube socket can be improvised. The total savings in this way would amount

Has a Range of 100 Miles

EXPENSE no longer need deter you from installing a thoroughly efficient vacuum tube radio receiving set with which to hear broadcasting. The set shown below can be assembled in two or three evenings at a cost almost as low as a good crystal set.

Built and tested by our Radio Department, it has been found to bring in stations within 100 miles with unfailing clearness and fine volume of tone.



The top and front views of the set. The tuning unit, or variocoupler, is at the left; the vacuum tube, grid condenser and grid leak in the center; the rheostat and batteries at the right

to \$2 or more, which could be applied to buying a better pair of phones or deducted from the total cost of the set.

If a new variocoupler is to be made or bought, it should have from 35 to 60 turns of wire on the primary and from 30 to 50 on the rotor.

The set is of the single circuit, regenerative type and the rotor of the variocoupler is used to provide regeneration. How this is accomplished is shown clearly by the wiring diagram and the photographs, which give the arrangement of the parts and connections between them. The antenna binding post or clip is mounted on the back of the panel near the upper left-hand corner. It can be seen in the top view of the set. The ground connection is made to the binding post or clip on the base shown in the upper left-hand corner, as seen in the top view. The phones are connected with the terminals shown just back of the variocoupler.

In the illustration the variocoupler is

shown mounted on a smaller block of wood, which in turn is placed on the main base. This was done because the coupler tube in this case was not long enough to raise the rotor shaft to the desired height. Whether you will use this arrangement depends on the type of coupler you buy or make.

In connecting the taps of the variocoupler with the switch points, start by connecting the tap which separates the single turn taps from the five or 10 turn taps, as the case may be, with the first tap of the "tens" switch, and then go outward from this point connecting each "tens" tap with a switch point in order. Then follow the same procedure in connecting the units taps with their respective switch points.

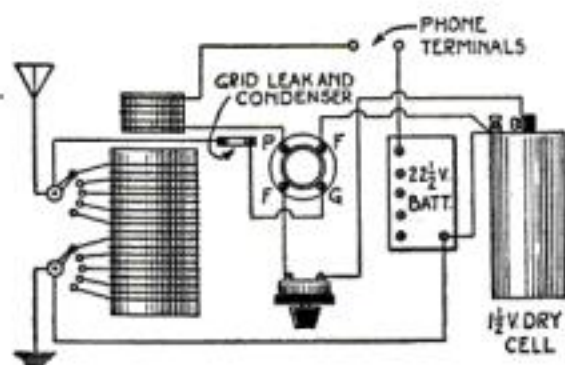
Hook up the connections with the rotor first one way and then the other; that is to say, one lead should be connected with the plate of the tube and the other with the phone terminal and then the leads should be reversed. Leave them where they give best results.

Any standard rheostat can be used and mounted by means of a small brass angle, as shown in the front view.

The set is very easily operated and is not critical in tuning, so that little difficulty is encountered in getting the various stations. It must be remembered that a dry cell tube must not be burned brilliantly; the rheostat should be turned up only until the filament of the tube shows a dull red color. Then the switch knobs should be turned to vary the number of turns in the circuit. This is done by setting the "tens" switch to a point and moving the units switch throughout its range, then shifting the "tens" switch another point and turning the units switch throughout its range, and so on until music or signals are heard.

Usually results are obtained when from 30 to 40 turns are in the circuit. When signals or music are coming in as clearly as

(Continued on page 104)



This pictorial diagram of the hook-up should be studied in connection with the photographs above

Parts To Be Bought and Their Approximate Cost

Vacuum tube	\$5.00	Binding posts (4)	
Socket	.75	Annunciator	\$.20
Grid condenser	.25	wire, 15 ft.	.10
Rheostat	.50	Wood screws, 1	
B battery	.75	doz., ¼ in.	.10
1½-v. dry battery	.40	No. 6	.10
Variocoupler	2.00	Aerial wire, 150	
Panel	1.00	ft.	1.00
Inductance		Aerial insulators	
switches (2)	.40	(2)	.50
Instrument dial	.30	Lead-in insulator	.10
Contact points		Lightning	
(14)	.70	arrester	1.25

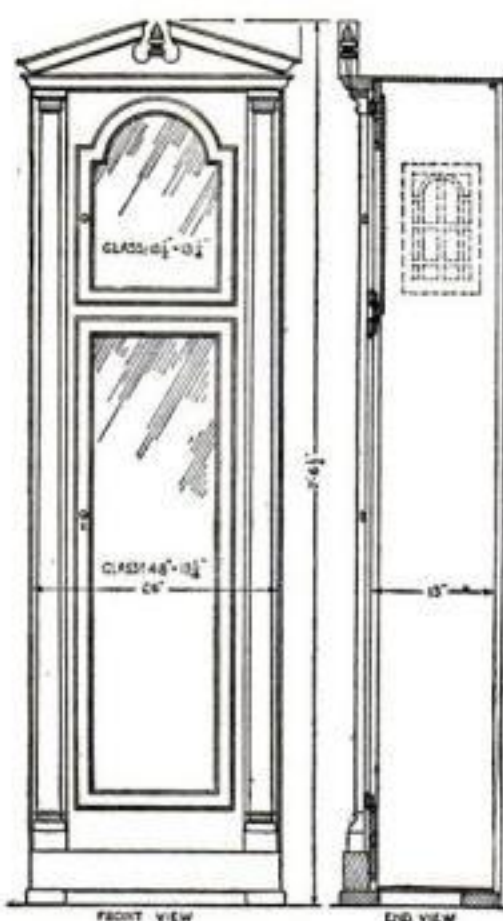
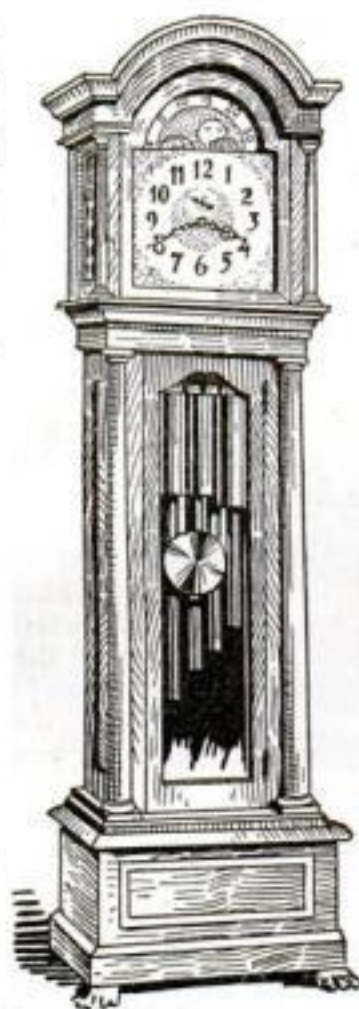
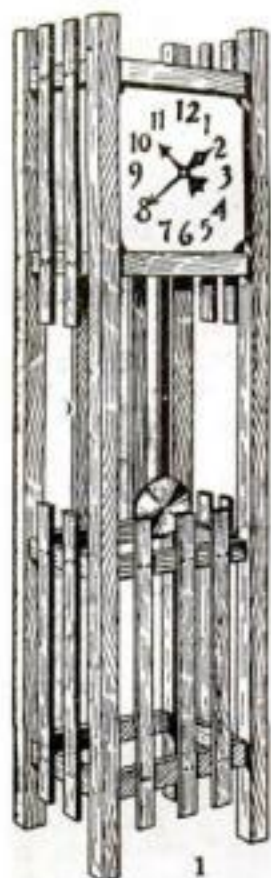
The total cost for these is \$15.30, to which must be added the price of phones, which ranges from \$4 upward.

Grandfather's Clock Cases You Can Build at Home

HOW many times have you heard the silvery chimes of a grandfather's clock sound melodiously in some fine old home and wished you had such a clock of your own?

To buy a commercial grandfather's clock is expensive, especially if the case is at all elaborate and the works of a good quality, but the home mechanic who is reasonably skilful with his tools and enjoys doing cabinetwork, can make the case at a relatively small cost for materials, and can buy, for prices ranging from \$5 to \$250 or more, clock movements and dials all ready to be installed.

Once made, the clock represents a value far in excess of the material that went into it. It is a permanent investment, like a fine painting. It will improve, if anything, with age, and in 100 years, with reason-

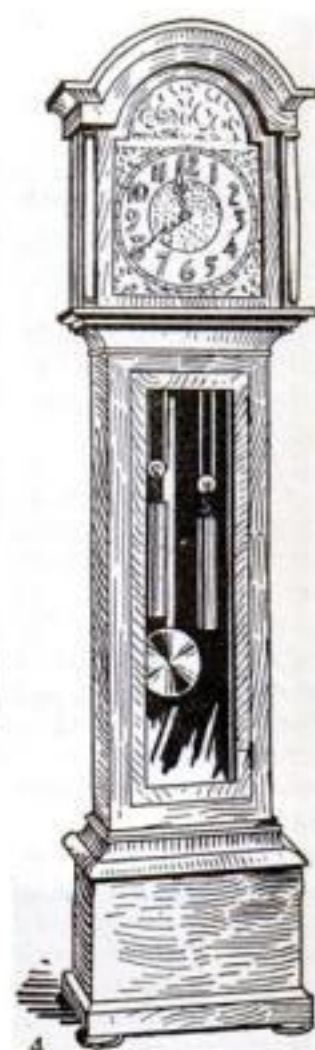


Resembling some of the finest modern floor clocks in its simplicity and quiet beauty, the case illustrated above is ideal for the amateur craftsman, because the construction is straightforward and not too difficult. Full size details and a complete bill of materials are contained in Blueprint No. 19 of the Home Workshop series. No. 1, at the left, is a so-called "Mission" clock, and Nos. 2, 3, and 4 are other homemade grandfather's clocks

capped with another molding and a small flat cap that supports the top frieze filling. Against this is fixed a molding that runs around the top of the case.

The top ornament, which is sawed from a piece $\frac{1}{8}$ in. by 6 in. by 2 ft. 5 in., is trimmed with a molding broken out at the center and returned upon itself. In the center is a key-stone with a turned and carved flame ornament or a plain turning, as preferred.

There are two doors, the upper one with an arched top that fits against the top face rail. The radius of the outside of the upper rail of the top door is $7\frac{1}{4}$ in. Back of the top door, fastened to the top and center face rails, is a mat cut out of a piece $\frac{3}{8}$ by 18 by 23 in. to



able care, will look as well, keep time as correctly, and chime as sweetly as when new. Many old-fashioned Colonial clocks are in perfect running order today and are worth much more than when the old-time cabinetmakers built them.

Designed especially for readers of the Home Workshop and simplified as far as consistent with good workmanship, the clock case shown at the top of the page, in the center, is one that is well worth the making. In its simple lines and fine proportions it resembles the best of the modern cases, and yet the construction is straightforward and simple.

In view of the amount of time required in making the clock and the comparatively small amount of stock required, a selected hard wood should be used, preferably mahogany, walnut, or quartered oak.

How the Case Is Constructed

The clock is 7 ft. $6\frac{1}{2}$ in. high over all, 2 ft. 5 in. wide, and 17 in. deep. The case is really a box, 7 ft. 1 in. by 2 ft. 2 in. by $13\frac{3}{4}$ in., the front of which is a frame made of two stiles $\frac{1}{8}$ by $4\frac{1}{8}$ in. by 7 ft. 1 in., and three rails. The upper rail is cut to conform to the curve of the top of the door, the center one is $\frac{1}{8}$ by 2 by 16 in., and the lower, $\frac{1}{8}$ by 8 by 16 in. Upon this are planted two pilaster stiles $\frac{1}{2}$ by $3\frac{1}{2}$ in. by 7 ft., and on these in turn are mounted tapered pilasters $\frac{1}{8}$ by $2\frac{1}{2}$ in. at the base. These have an ornamental base composed of a molding and the base block, which rests upon the main base, $2\frac{1}{2}$ by 4 in. by 2 ft. $2\frac{1}{2}$ in. At the top the pilasters are



Courtesy the Metropolitan Museum of Art

An unusually elaborate Colonial grandfather's clock

frame the dial of the clock.

The ends can be solid or cut out, as shown by the dotted lines, for small fret-saw doors backed with silk. These act like the doors of a phonograph sound chamber and allow the sound of the chimes to escape in greater volume. The openings can be as small as 4 by 5 in., simply backed with silk, if desired, to avoid the work of making the doors.

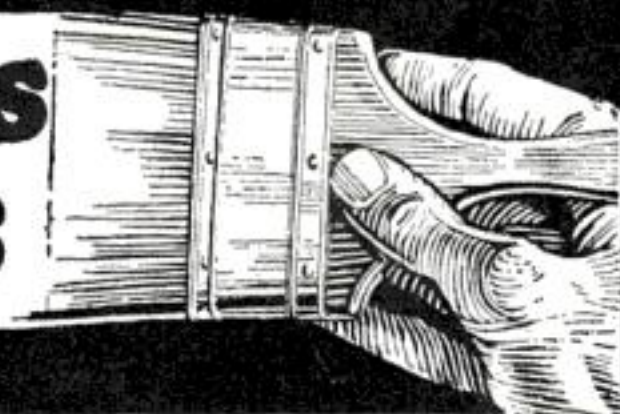
The back is poplar, whitewood, pine or other soft wood, lipped on the edges with wood to match the rest of the case. It projects $\frac{1}{4}$ in. beyond the ends, as indicated by the double line on the front view. In other words, while the case itself is 2 ft. 2 in. wide, the back is 2 ft. $2\frac{1}{2}$ in. wide.

Base Block Is Mitered at Ends

The base block is also 2 ft. $2\frac{1}{2}$ in. long and, to avoid showing the end grain, it is mitered at the ends, and filled in with two small mitered pieces that show the edge grain. The feet are simply blocks $1\frac{1}{4}$ by 4 by 4 in., with the corners rounded. The top of the case is $\frac{1}{2}$ by $13\frac{3}{4}$ by 2 ft. $1\frac{1}{2}$ in. and the bottom $\frac{1}{2}$ by $12\frac{1}{2}$ by $24\frac{1}{4}$ in.

Full size details showing the more important points in the construction of the case, as well as a sectional plan view, two full size alternate designs for the ornamental turnings, and a full size templet of half the upper door frame are contained in Blueprint No. 19 in the Home Workshop series. This also contains a complete bill of materials with dimensions and notes. It will be sent to any reader for 25 cents to cover the (Continued on page 111)

How You Can Change Odd Pieces Into Masterpieces



ATTICS, store rooms and barns are full of old pieces of furniture—out of style, perhaps, but they can easily be made attractive and useful. Perhaps all they need is refinishing to conform with the present styles. This can easily be accomplished at practically no expense. All you need is a little time, a brush and

JOHNSON'S WOOD DYE

Johnson's Wood Dye is very easy to apply—it goes on easily and quickly, without a lap or a streak. It penetrates deeply, bringing out the beauty of the grain without raising it—dries in 4 hours and does not rub off or smudge.

Johnson's Wood Dye is made in fourteen beautiful shades, all of which may be easily lightened or darkened—full directions on every label.

Our FREE Book Tells YOU How

This book tells how to finish wood in artistic stained and enameled effects. Gives practical suggestions on making your home attractive, cheery and inviting. Tells just what materials to use and how to apply them. Use Coupon Below.



This book is the work of experts—profusely illustrated—contains color charts—gives covering capacities, etc. We will gladly send it free and postpaid for the name of your dealer. Fill out and mail coupon at right.

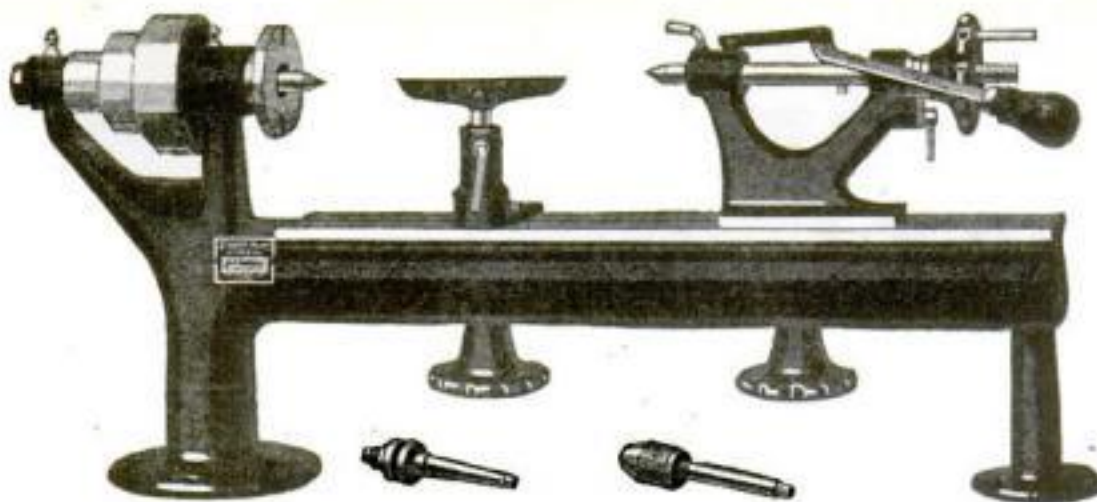
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RACINE, WIS.** (Brantford and Montreal—Canada)
Please send me free and postpaid your book on
Home Beautifying and Wood Finishing.

My Paint Dealer is

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Bench Lathe No. 125

Price, \$36.00

Length over all, 25 inches.
Height 11-1/2 inches. Swing, 7 inches.

Do all the work at home

YOU start to work out a mechanical idea at home. You can do all the work up to a certain point. Then you must let some one else complete it. Because you do not have a bench lathe, you lose all the satisfaction and pleasure of finishing the experiment yourself.

A Goodell-Pratt Bench Lathe will enable you to complete your work without machine shop delays and charges. You work out the idea for the cost of material alone.

One model, that shown on this page, answers every need of the home worker and experimenter. It is moderate in price, and accurate, and will give you long service.

Another size has a larger Tee Rest and a longer Bed. Otherwise both are alike. There is hardly a machine operation done on larger lathes that cannot be done on these Goodell-Pratt machines by using special attachments.

Every lathe is provided with an adjustable Tee Rest, a Slotted Face Plate, a Saw Arbor and a Drill Chuck with a No. 1 Morse Taper Shank. The Chuck holds round shanks of all sizes from 0 to 1/4 inch.

Write us for our free illustrated booklet, "Bench Lathes," and catalog No. 14, showing all the Goodell-Pratt 1500 Good Tools.



GOODELL-PRATT COMPANY, Greenfield, Mass., U. S. A.

Toolsmiths

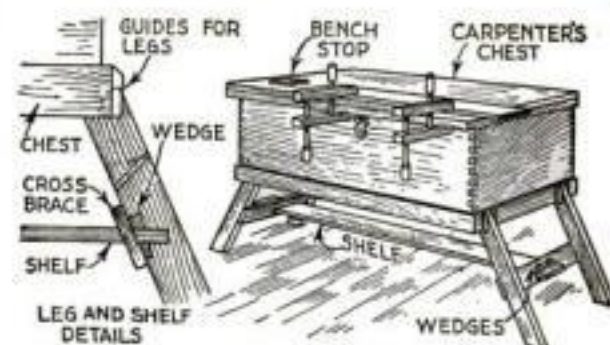
GOODELL-PRATT

1500 GOOD TOOLS

THE HOME WORKSHOP

Legs Convert Carpenter's Chest into Portable Workbench

A CARPENTER who has a great deal of elaborate cabinet repair work to do away from his shop, uses an ordinary carpenter's toolchest as a bench by supporting it on legs, as shown. The legs are notched to take the chest and are prevented from slipping by guide strips screwed to the ends of the box. The legs are connected in pairs with cross rails, which are mortised in the



Fitted with strongly braced legs, this large toolchest serves as a woodworking bench

center to take long tenons at each end of the central shelf or brace. These tenons are held by wedges.

On the top of the box is a simple wooden bench stop for use in planing operations. Pieces that have to be held rigidly on the bench are clamped with hand screws to the projecting rim of the lid, thus doing away with the necessity for a vise.

For the home carpenter who has no room for a large bench, an arrangement like this can be used advantageously because it takes up little more room than the toolchest alone and can readily be moved from place to place.—F. S. E.

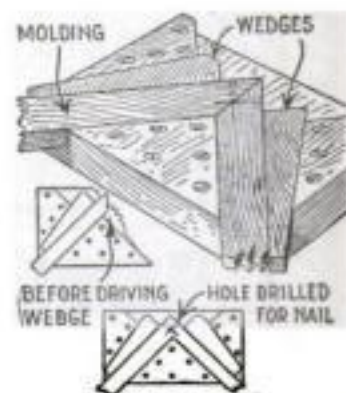
Simple Wooden Vise Aids in Joining Picture Frames

THREE blocks screwed to a base block or the bench, as shown, form a substantial and quickly made picture frame vise for the home workshop. Two wedges are used to clamp moldings of various sizes in the vise.

Every precaution must be taken to have the face angles of the inside block just 90 degrees, and all bearing surfaces of blocks and wedges should be planed at right angles to their sides, as otherwise the wedges will not hold well and the moldings may not lie flat. All the parts should be made of a hard wood such as maple or oak, and plenty of screws used.

In planing the molding in the vise, a slight allowance should be made for the tendency of the wedge to carry the molding along with it as it is driven home. Then, when the pieces are clamped, a hole should be drilled through each piece and started into the other piece, the holes being slightly smaller than the brads or nails that are to be used.

Any one who has struggled to nail a mitered frame in an ordinary vise will appreciate this simple fixture.—ROBERT N. STANNARD, Eltingville, N. Y.



Wedges hold the molding in place for nailing

Immediate Demand for New Cunningham Amplifier Tube



Type C-301-A List Price \$9.00

The most efficient vacuum tube ever placed on the market for amateur and experimental use. The engineers of the General Electric research laboratories have at last succeeded in perfecting a tube that every owner of a radio set has been waiting for.

Greater Power Amplification Only $\frac{1}{4}$ Amp. Filament Current

THIS new and improved Cunningham C-301-A Amplifier is a high vacuum tube designed for use as an amplifier and detector, containing a new Tungsten Filament, the characteristics of which are long life, low power consumption, low operating temperature and greater power amplification than any previous amplifier tube. The tube has a standard four prong base, and the glass bulb has the same dimensions as the C-300 and the C-301.

The greatly reduced filament current permits the use of four of these tubes without exhausting the A battery any faster than when using one of the previous type of amplifier tubes.

Complete instructions for the care and efficient operation of this new Amplifier Tube are packed with every tube.

Insert a C-301-A in your amplifier set today. Note the improved quality and increased audibility.

The Cunningham Technical Bureau is at your Service. Address your problems to Dept. P

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248 First Street
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Better Shop Methods

How Expert Mechanics Save Time and Labor



Simple Shopmade Filing Machine Saves Hand Work

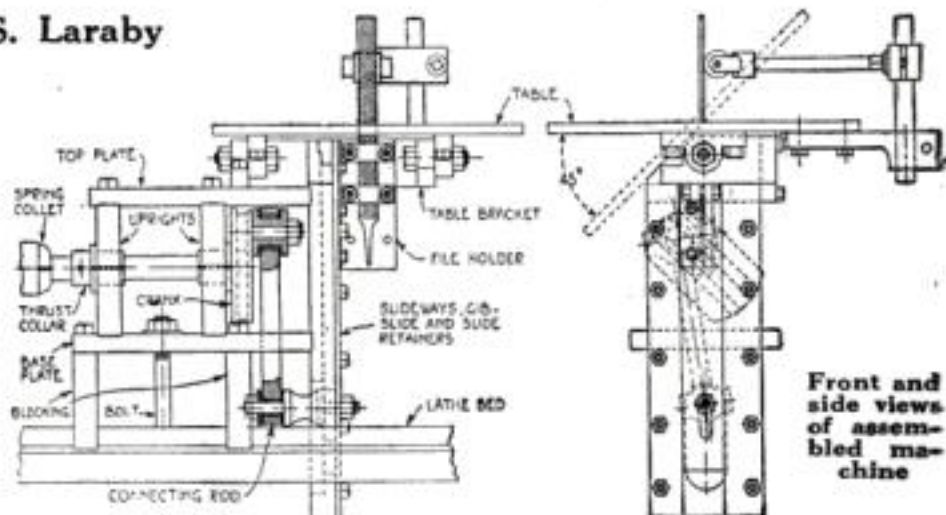
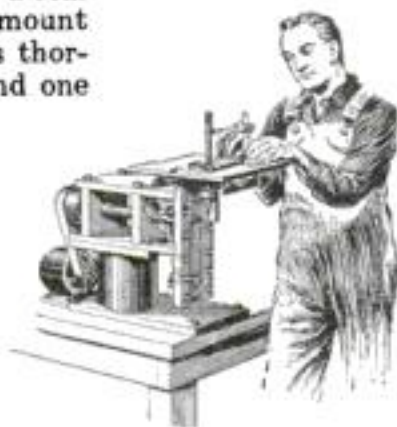
By Henry S. Laraby

FOR the average shop, this sturdy yet simply made filing machine is a real time saver. It reduces the amount of tedious bench work and performs thoroughly and efficiently a thousand and one laborious filing jobs.

The machine can either be used as a lathe attachment, or it can be mounted on the bench or on a pipe floor stand, and driven by a small motor or other source of power.

Requiring no castings or parts difficult to machine, it is, nevertheless, of sturdy, substantial construction and will stand up under ordinary shop usage for years. Adjustments are provided for compensating for wear at all vital points, so that the small machine runs smoothly at all times.

The construction of the parts is shown in such detail in the accompanying illustrations that little explanation is required. When used as a lathe attachment, the bed plate is bolted to the lathe bed and the



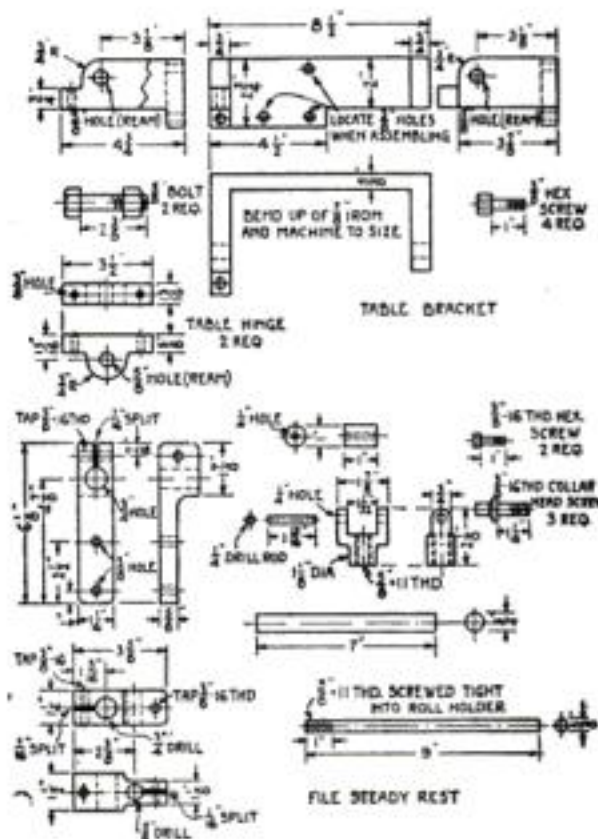
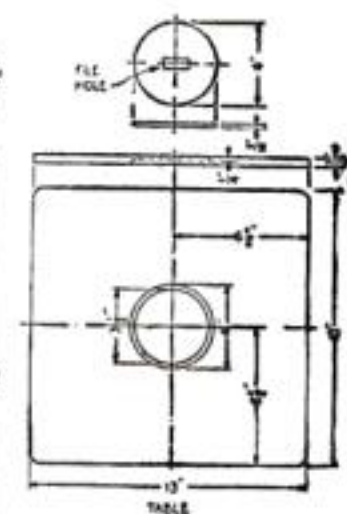
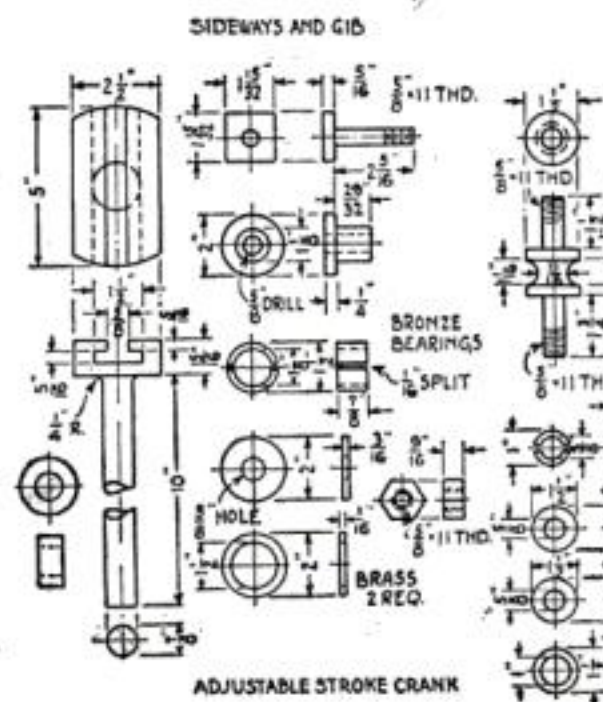
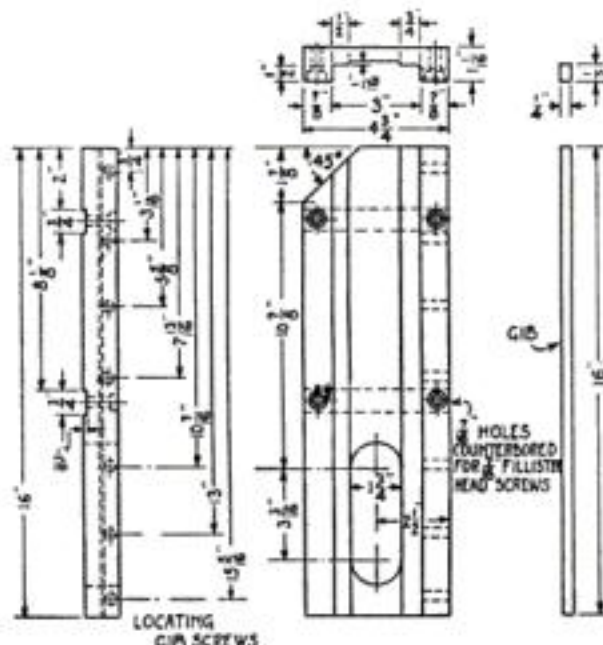
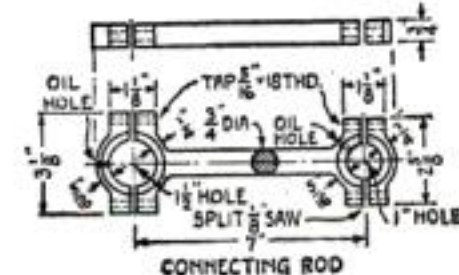
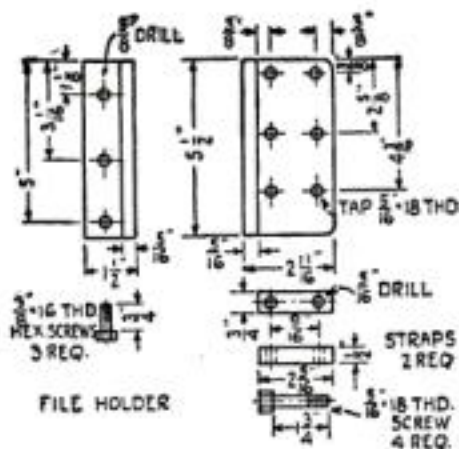
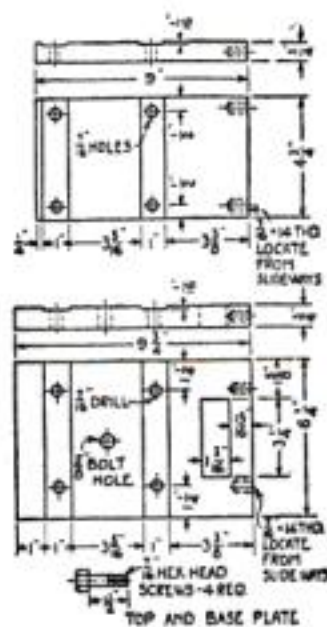
shaft is driven by means of a spring collet. A crank and connecting rod convert the rotary motion of the spindle to a reciprocating motion, and the file, held in a file holder, slides up and down. The crank is designed to give an adjustable stroke with a maximum range of 3 in.

The fact that the entire machine is made

of machine steel, with the exception of a very few parts, adapts it for construction in the average small shop where there might be more or less objection to having special castings made.

While the bearings may seem somewhat elaborate, since they are split instead of

(Continued on page 81)



Fully dimensioned working details of the top and base plate, table and table bracket, connecting rod, adjustable stroke crank, sideways and gib, slide and slide retainers, slide pin, file holder, and steady rest. See page 84 for the uprights, and shaft bearings

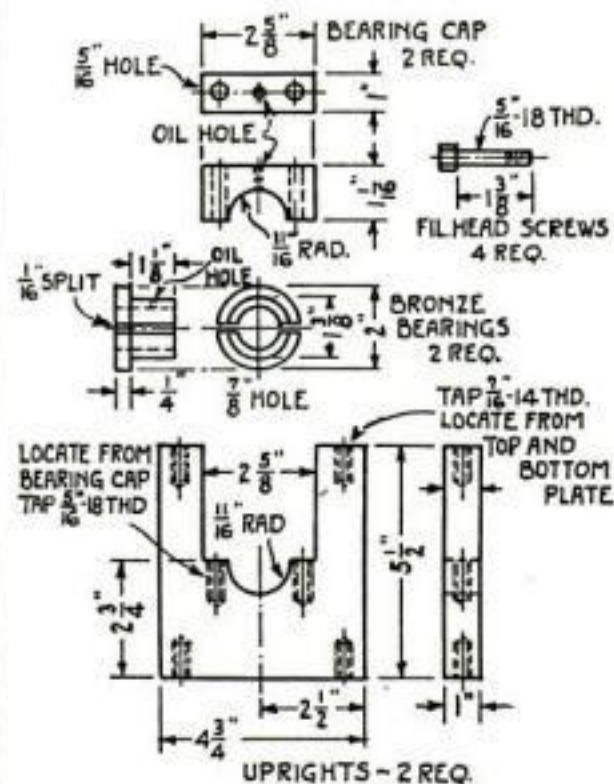
BETTER SHOP METHODS

Simple Shopmade Filing Machine

(Continued from page 80)

solid, they will be the best in the end, as any wear can be taken up, and the machine will run for years without new bearings. The ordinary round bearings get oval after a time and this will cause a clank and jerk on a machine like this, so that it would run smoothly only for a relatively short time.

Note particularly that the slide is 9/16 in. thick, while the slideways are only 1/2 in. deep, so that the slide retainers must be



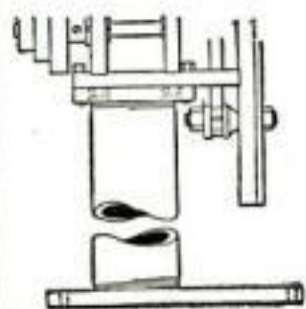
How the main uprights and bearing caps are made, and details of the bearings

shimmed up 1/16 in. This allows for adjusting the slide retainers to take up the wear in slide and slideways.

The machine was designed after one I saw in a jobbing shop, but several improvements have been incorporated. The original machine, which has a frame of cast iron, also has a 3-in. stroke, but is limited in the range of the angles at which the table can be tilted. While the excessive angle of 45 degrees possible with the table of this machine is not necessary for die work, which seldom exceeds a 3-degree

angle, a tilting table of this range is handy for many jobs that come in the line of filing.

On the original machine, when a short stroke is used, the file holder does not come up close under the table on the up stroke and is quite a distance



Mounting the machine on a pipe pedestal

away on the bottom stroke. This gives quite a spring to the file, and I have remedied the difficulty by putting an adjustable slot in the slide itself, so that, when using short strokes, the slide can be adjusted to go up close under the table. I have also made the slide narrower, so that the extreme width of the part that goes down through the lathe bed is 4 3/4 in. This will allow its use on the average lathe.

Kerosene Used in Scraping

THE formation of deep scratches in scraping cold rolled stock or tool steel, will be greatly lessened if kerosene is applied to the surface.—B. H. U.

The World's Greatest Truck Value!

RUGGLES

A Truck Produced and Serviced by Transportation Experts

The great Ruggles organization is made up of trained transportation experts. The factory specialists know how to build trucks to meet commercial needs. The local dealer applies transportation principles to the economical moving of your product.

Ruggles Trucks are built to perform definite service. They are strong, powerful, dependable. They have the power to carry your load and the speed to maintain your schedules.

Ruggles Trucks are built of the finest material that long experience and tremendous buying power can command. The durability thus secured—and the low cost—makes them admittedly the *world's greatest truck value*. A unit for every haulage need at chassis prices from \$795 to \$1995.

Ask the nearest Ruggles dealer for an expert opinion on your transportation problem. Write us for illustrated literature.



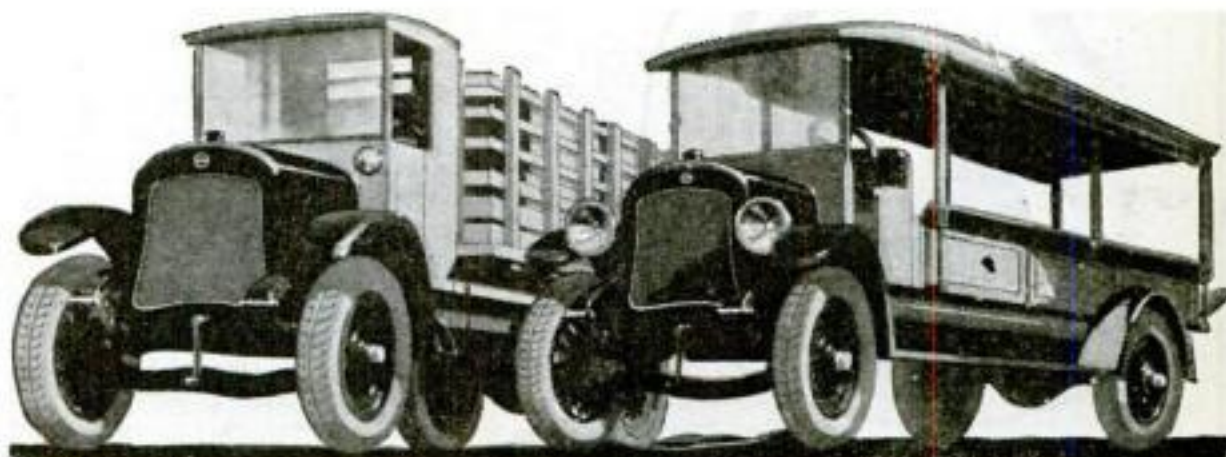
Modern Transportation Offers New Business Opportunity

Commercial transportation offers a big field today. Small capital required. Hundreds are making big incomes operating bus and express lines.

Can You Sell?

We have some territory still open and want men to represent the Ruggles National System of Transportation Economy. Business men come to you for transportation counsel. This is an opportunity for men with vision and imagination. Write us today for full particulars.

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"That's Davenport"

He always says "Davenport I-o-w-a where the West begins."

Instantly recognized. Distinct, clear as a bell the voices and music, within the radius of your outfit, come to you if your radio is equipped with the

Stromberg-Carlson Radio Headset

Quickly adjustable to any size head, very comfortable and so sensitive, faint long distance signals are reproduced accurately.

Its forked cord construction makes it do double duty when necessary. The receivers can be separated and used by two observers at the same time.

Backed by 8 years' experience in the manufacture of radio apparatus and 28 years' experience in the manufacture of high grade telephone equipment.

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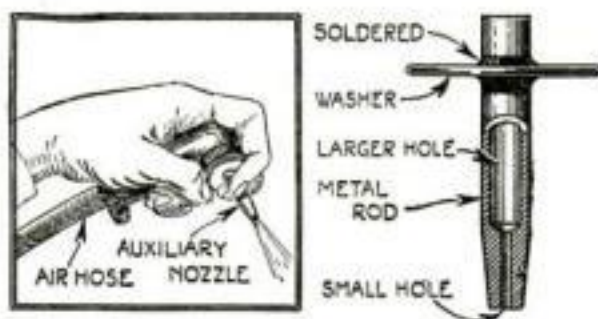
**STROMBERG-CARLSON
TELEPHONE MFG. CO.
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BETTER SHOP METHODS

Detachable Cleaning Nozzle Fits in Air Compressor Coupling

IT IS desirable to have a nozzle with a small jet for use on the acorn type of coupling for the air tank or compressor. This serves many purposes, such as for



Pressing the nozzle into the coupling makes a powerful air stream available for cleaning

blowing out pipes and removing particles of carbon from cylinders.

A serviceable jet that can be applied quickly is the one illustrated. It consists of a cylindrical bar drilled with two holes, a large hole at one end and a small hole at the opposite end. Over the bar a washer is soldered or brazed to form a finger hold when the nozzle is inserted in the coupling. The pressure of the fingers keeps the valve open.

This fixture is easily made and is a time saver whenever a jet of air is required for cleaning purposes—E. L. Y.

Funnel Guard for Drill Chips

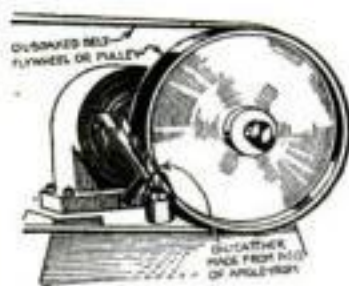
WHEN drilling overhead holes in metal with a hand drill, a guard to catch the chips may be made by placing a small funnel over the drill point. This expedient is used regularly by a Washington, D. C., mechanic in drilling holes in car frames from beneath. He adopted it after a falling chip had nearly cost him the sight of one eye.

In boring overhead holes with a brace and bit, a similar guard may be used to advantage.—M. C. F.



Removing Oil from Drive Belts

OF MANY methods suggested for removing oil from oil-soaked drive belts, such as washing with gasoline and applying chalk, one of the best is to shape a piece of sheet iron of fairly heavy weight, as shown, and mount it on a temporary holder so as to hold it in a diagonal position against the face of the engine flywheel. The iron will soon be ground to a knife edge. The oil on the face of the flywheel will then be skimmed off and in a short time nearly all the oil in the belt will have been extracted.—ROBERT SCHROEDER.



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The "Red Devil" Chain Drill No. 2018 costs, but \$4.80, and pays for itself in a short time. On sale at responsible dealers, or direct from our factory.

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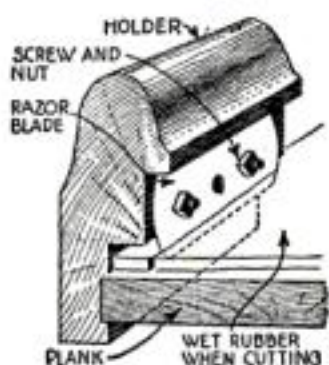
"Red Devil" Glass Cutters—the glaziers' standard tool of the world. "It's all in the wheel." Made in 40 styles. No. 024 shown below, 20c



BETTER SHOP METHODS

Cutting Belt Laces and Rubber with Razor Blade

FOR cutting strips of leather to make belt laces, or for preparing narrow strips of rubber such as are used against glass in the windshields and windows of automobiles, the tool illustrated will save much time. It is simply a wooden holder, shaped



The blade holder serves as a gage

as shown, to which is attached a safety razor blade.

The leather or rubber to be cut is placed on the edge of a plank and the tool is drawn along the edge, something like a marking gage. It is easier to cut the rubber

smooth and straight if it is first wet with water.

If the guiding rabbet of the holder does not slide as smoothly as desired, rub the edge with soap. The razor blade can be replaced when dull.—L. D. P.

Saving the Air Tools

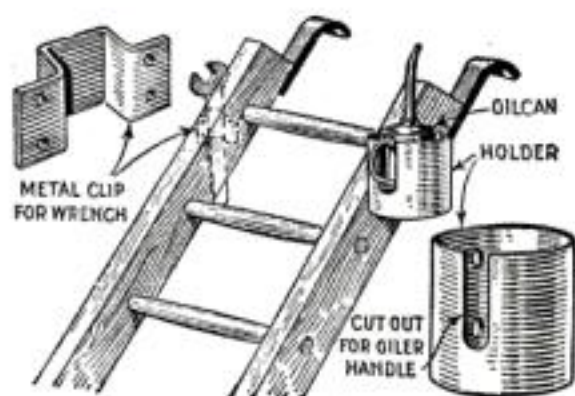
FROM personal experience as a repairman on air-driven tools, such as drills and riveters, a friend has found that advice regarding their care is badly needed.

The working parts of such tools, especially the valves, are fitted to close limits and should be carefully protected from dirt. As most of my friend's repair work is caused by scale and dirt from the air pipe line, he prevents some of the trouble by placing short pieces of pipe in the air line. These collect any scale or dirt that might be rolling along the bottom. He also continues the end of the line a little beyond the last branch of the air line to form another pocket for dirt and scale.

When piping new lines, he takes all the branch lines off the main line at the top and puts in a dead end dirt pocket for each one, because while many air tools have strainers in them when new, the strainers often are lost.—F. H. SWEET.

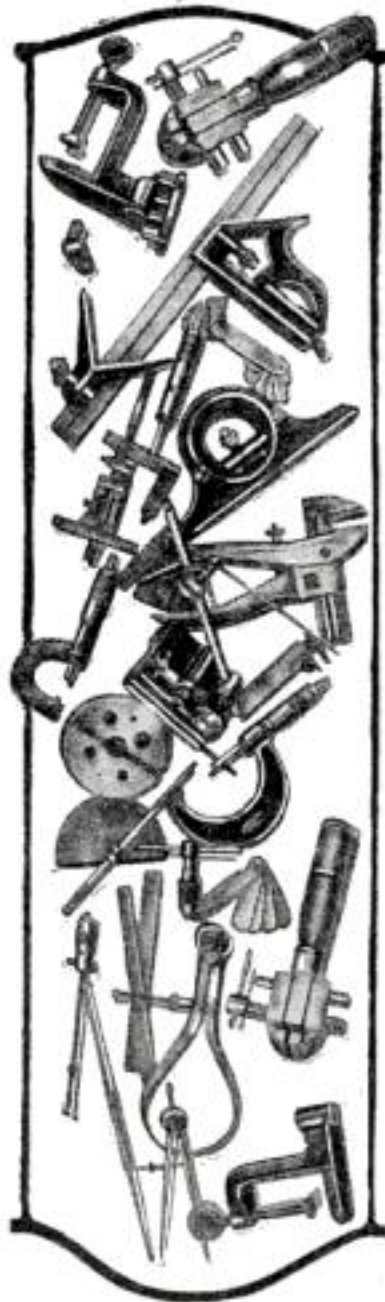
Line Shaft Oiling Made Easier

THE line shaft oiler will find his work simplified if he equips his ladder, as shown, with a holder for the oilcan and a clip for the wrench used in tightening



Wrench and oilcan kept handy in holders

bearing-box bolts. The container for the oilcan is simply a heavy tin can of suitable size. It should be deep enough so that there will be no danger of the oilcan falling out when the ladder is shifted.—E. N.



A

Write your letter on this subject:

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Cover these points:

1. Superior features of Starrett Tools.
2. Advantages of any particular Starrett Tool.
3. Number of practical uses I have found for the tool chosen above.

Note! Contestants to be eligible must have used Starrett Tools prior to Feb. 10th, 1923.

Mail to Contest Editor, The L. S. Starrett Co., Inc., Athol, Mass., not later than April 15, 1923.

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Any machinist, carpenter or mechanic in the United States or Canada can enter the Starrett Prize Contest. If you use Starrett Tools, you know why you prefer them. Put down your reasons in plain language and send them in.

474 separate prizes of Starrett Tools (sets and individual tools of your own selection) will be given for the best letters. (See "A" above for points to cover.) All Starrett tool users have an equal chance. Literary skill doesn't count in this contest. *Facts will win the prizes.*

You can get all the details at any store selling Starrett tools. Ask for the free Prize Contest Booklet containing free instructions, description of prizes, etc.

(Write for copy if dealer can't supply you.) Mail your contest letter promptly. You may win the Grand Prize—\$150 worth of Starrett Tools (list prices) of your own choosing. And there are 473 other prizes. Enter today. Contest closes April 15, 1923.

Write for Starrett Catalog No. 22 "W" and the Supplement describing the new Starrett Tools.

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ATHOL, MASS.



Starrett Prize Contest

When You Bore Holes Look at the Bit

The business-end of a bit is its cutting head, and the kind of head it has makes a big difference in its cutting qualities.

Irwin bits are made with carefully designed cutting heads to meet each boring requirement.

And in every IRWIN Bit you will find perfect co-ordination between the essential parts—the Screw, the Spur, the Cutter, and the Throat.

The Screw—No. 1

The pitch of the screw determines the speed at which the bit will bore. Hence, the kind of boring done should determine the pitch of screw used.

The Cutter—No. 3

This cuts under the chip after it has been scored by the spur, and starts the chip upwards to the throat of the bit. That's why cutters must be well tempered, keenly sharp, and evenly balanced, otherwise the bit will "drag."



The Spur—No. 2

The length of the spur must conform to the pitch (or speed) of the screw to make the cutting smooth and easy.

The Throat—No. 4

Free passage must be given the chips to permit an easy flow up through the "twist" of the bit. That's why IRWIN Bits have roomy throats;—they can't "choke" and "clog."

If you want to bore easily cut, smooth holes in ALL kinds of wood,—holes that are "cut true clear thru,"—ask your dealer for the IRWIN Bit. Look for the IRWIN Trade Mark on the shank of the bit and the IRWIN Guarantee Tag. These are your protection and assurance of IRWIN Boring Service. Get our booklet, "How to Select, Use, and Care for Bits." It's free.

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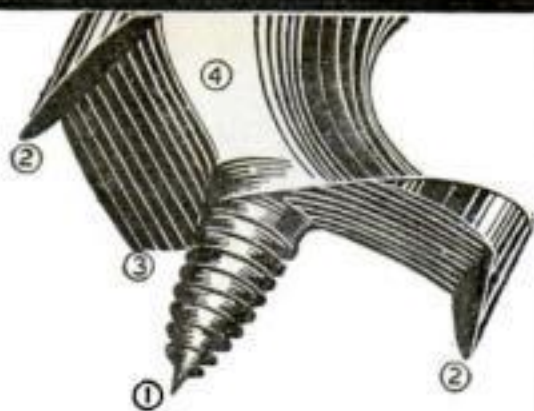
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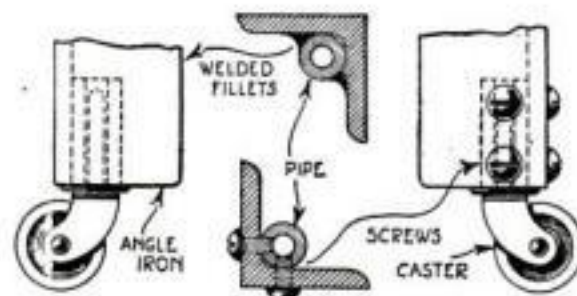
Providence, R. I., U. S. A.



BETTER SHOP METHODS

How to Fasten Casters to Angle-Iron Legs

PLAIN angle-iron legs, which are used frequently on office furniture such as filing cabinets, drawing tables, and racks, can be improved if provided with casters.



Short lengths of pipe form the sockets for these casters

This can be done by using a piece of pipe to form the socket for the shank of the caster and fastening it in the angle by either of the methods illustrated. One is by welding and the other by drilling the angle iron for $\frac{1}{4}$ in. round head screws and tapping the pipe to suit.—J. R.

Cheap Shop Floor Made of Earth and Iron Chips

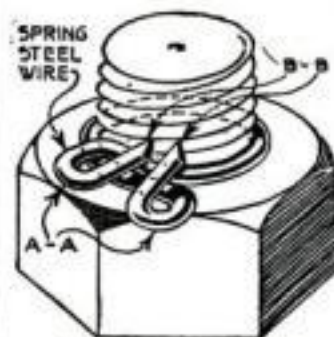
IN THE outside shop, blacksmith shop, or even a garage used for trucks, a serviceable floor may be made at practically no cost if iron or steel chips from the machine shop can be obtained. The earth floor is pounded down solidly, preferably with a layer of clay, or earth and clay, on the upper surface. Over this a mixture of steel chips and salt is placed to form a covering $\frac{1}{2}$ in. or more in depth. Sprinkle water over this and tamp it down solid. The mass will soon rust and form a covering almost as hard as cement.

Unless the crust is broken, this floor will stand an unusual amount of usage without breaking up. This is a practice followed by some blacksmith shop owners, and if there is a blacksmith shop near by, an inspection of the floor probably will show how the particles of iron chips have made a substantial floor, whether salt has been added or not to hasten the rusting.—G. M. E.

Spring Nut-Locking Ring Quickly Put in Place

A SIMPLE nut-locking device, designed and used by J. C. Huffer, a Denver, Colo., mechanic, is made and fitted in place as follows:

Bend a length of spring steel wire into the form of a circle and loop the ends A A so that the points B B project within the inside diameter. Enlarge the circle by pressing together the loops and slip the locking ring over the end of the bolt until it is in place against the face of the nut. Then release the loops so that the points will spring into contact with the bottom of the bolt thread, exerting sufficient radial pressure to keep the device in place under shock or vibration.—LELAND F. JAMES.

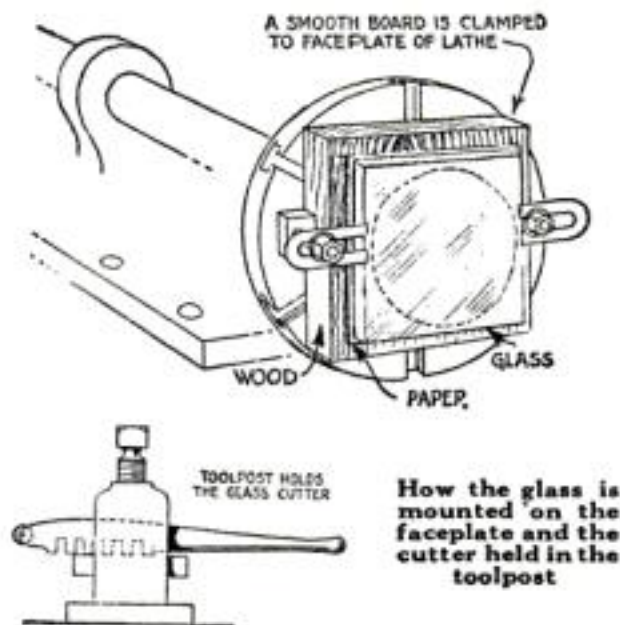


Prevents the nut's loosening

BETTER SHOP METHODS

Glass Disks Quickly Cut with Glass-Cutter in Lathe

THE cutting of circular glass disks for gages, ammeters, headlights, and the like, can be done expeditiously with an ordinary hand glass cutter mounted in the tool post of a lathe. A flat board or block with a smooth surface is mounted on the faceplate and the glass is secured to the wood by means of a piece of paper glued on

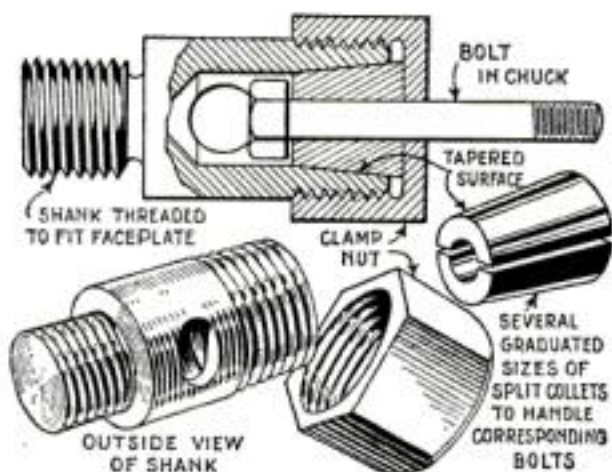


both sides. The glass cutter is set in the toolpost, rather close in to avoid overhang.

Without waiting for the glue to dry, bring the tool nearly against the face of the glass and gage the size by turning the lathe and using a pencil to mark the position of the cutter. The cutter is then fed to bear about as heavily as in making a cut by hand. Several turns in the lathe mark the outline, and the glass is removed before the glue dries. The waste edges of the glass are then removed in the usual way by tapping them lightly.—M. G.

Chucking Fixture for Bolts

A SPECIAL fixture for chucking hexagonal head bolts in a lathe while chasing the thread farther down the bolts and cutting them off short, was made as shown. By using a series of split collets with inside diameters to correspond to the bolts being



Parts of the chuck and diagram, showing how it is used to hold bolts

machined, one fixture will serve for several sizes.

A shank threaded to fit the lathe faceplate is drilled to accommodate the heads of the bolts, and a taper is turned in one end to correspond to the outside taper of the split collets. A clamp nut is provided and a cross hole is drilled through the shank, so that a drift may be used to release the bolt and collet if they become jammed.—C. O.

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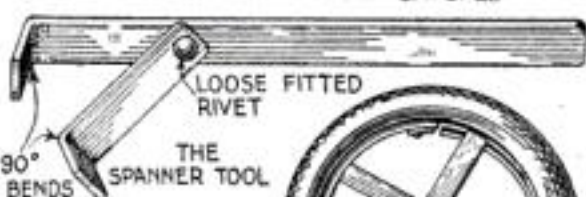
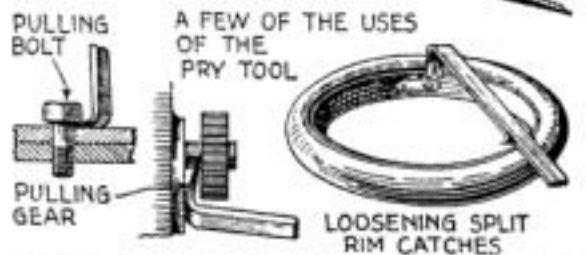
51 Pearl St. Boston, Mass.

BETTER SHOP METHODS

Pry Bars and Spanner Tools Made from Spring Blades

THE pry bar and spanner tools illustrated were made to expedite the work in a busy auto repair shop. Their cost was negligible inasmuch as broken car springs provided the material.

The pry bar was designed for general service, the "V" openings being used in pulling bolts, collars and small gears. The offset end was formed for getting into tight



Inexpensive shopmade tools for heavy work and some of their uses

places. As a tool for working on tire rims and replacing casings, it has also given good service. The ends will hook or unhook the majority of fasteners on split rims.

The spanner tool has many uses. With it a flywheel may be gripped and turned, transmission and timing gears twisted on their shafts, and key slots and setscrew holes lined up. The double ends serve either for pushing or pulling. For example, the tool is used to collapse a split tire rim by butting the straight end against the inside of the rim and hooking the opposite end over the other end of the rim.

These tools are each about 2 ft. in length and the ends are quenched while hot to retain some of the tempering, so that they will not be too soft.—F. L. W.

Inking Small Circles

DRAFTSMEN who have occasion to draw many small circles, as in structural steel work for indicating rivet holes, or in map drawing, often have difficulty in preventing the small circles from filling up. This is because the pivot leg of the drop bow pen drops so far down that the thicker part of the point touches the pen. A paper sleeve, applied as shown, will prevent this.—P. A. DASCHKE.



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BETTER SHOP METHODS

Secrets of Success in Grinding
Thread Cutting Chasers

By John L. Chambers

OF ALL the tools used in the metal trades, few are more abused or less understood than the chasers used for cutting threads on pipes or bolts. Chasers become dull from use and misuse and must be resharpened. Yet to recondition them properly requires care and experience.

The terms used to distinguish the chaser parts are "lip," "rake," "throat," or "lead," and "clearance." Referring to the illustration, it will be seen that a common lathe tool, set against a bar of stock, has been used to show the meaning of the terms and their application.

A lathe tool with a flat top is said to have no rake or lip. When used to remove or

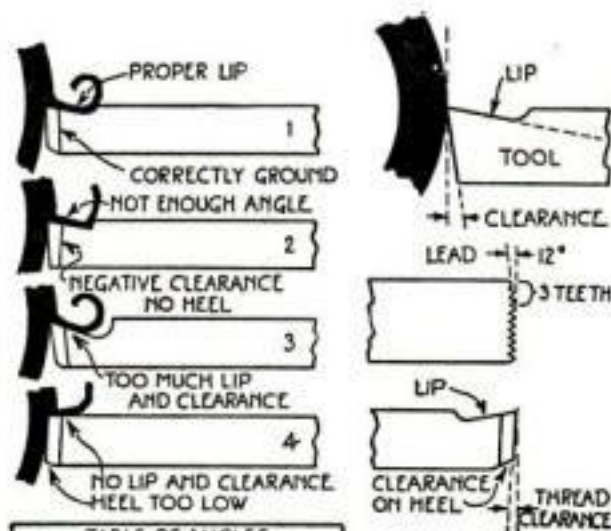


TABLE OF ANGLES			
MATERIAL	SOFT	MEDIUM	HARD
LIP	20°	15°	10°
LEAD	12°	12°	12°

How the chasers should and should not be ground, and angles for the lip and lead

turn off metal, it pushes rather than cuts the chip, consumes much power in the operation, and leaves a rough and unfinished surface. If the tool is ground with a receding slant, it will curl the chip and takes less power than the flat top tool. A tool so ground has lip or rake, and gives a very good finish to the work.

Too much lip or rake reduces the cross section of the tool immediately in the rear of the cutting edge; it cannot, therefore, carry away the heat fast enough and burns readily, and also is apt to gouge and dig in.

"Lead," "chamfer," or "throat" designate the part that first enters the stock or pipe; it is a tapered section on the first three full threads of the chasers.

"Clearance" is the backing away of the tool's lower surface, immediately behind or below the cutting edge. Without clearance a lathe tool would rub and soon burn from the heat generated by the friction.

Like Other Lathe Tools

Since a pipe or thread chaser is only a multiple cutting tool, the same rules apply to it. When imperfect threads are cut on either bar or pipe stock, a diagnosis should be made from the standpoint of the familiar lathe tool.

New pipe chasers often give trouble by not having enough lip and chip clearance ground on the front cutting faces. The proper lip angle depends much on the hardness of the material to be worked. The appended chart gives the proper angles for varying hardness as of stock or pipe.

(Continued on page 88)



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BETTER SHOP METHODS

Success in Grinding Chasers

(Continued from page 87)

The end of the lip or rake should terminate in a generous radius to cause the chip to curl when striking the chaser. If ground with a sharp corner, the chips may break or become clogged, thus marring and spoiling the otherwise good threads.

The operator has no control over the clearance of the threaded portion of his chasers, and if it is not sufficient to cut good threads, the chasers must be discarded. The clearance of the throat or lead of a set of chasers must frequently be reground, as this constitutes the rough cutting part of the tool, and becomes dull from wear caused by the scale and grit embedded in the outer surface of the stock. This clearance should be a little greater than that on the threaded part, and must be ground alike on all members of a set. Great care must be exercised in this, so as to secure even cutting and the same removal of stock by each individual chaser.

The angle of the lead will vary slightly with the kind of stock worked upon; a long lead will cut true and easily, while a short lead will start hard and cut hard.

Grinding the Relief or Heel

A relief or heel is ground on the back edge of the chaser teeth, as shown, to prevent them from tearing off the threads. It should be deep enough to cover the whole depth of the teeth. The grinding should be done on a surface grinder, using a swivel head vise. Where a surface grinder is not available, the work can be done on the common type of bench grinder, but good judgment must be used to grind all of a set in the same manner.

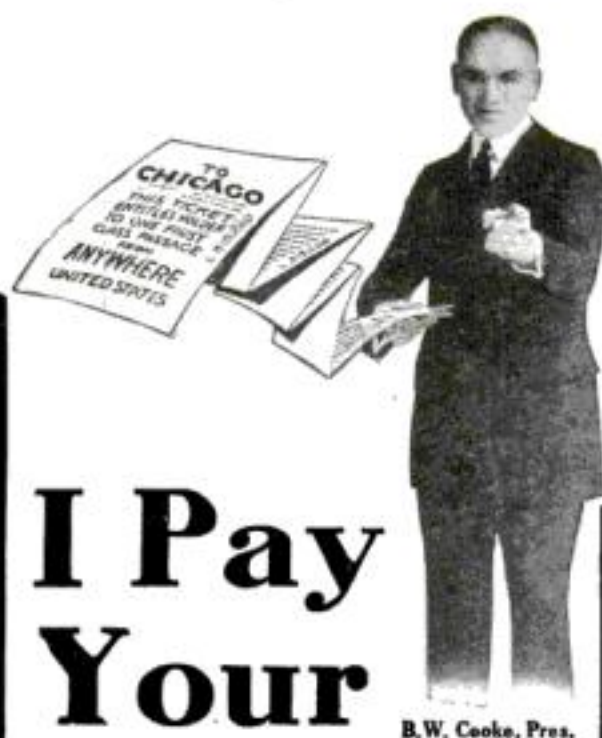
Referring to the illustration on page 87, No. 1 is correctly ground in every respect. Number 2 has too little lip, a negative clearance in the throat, and no heel at all. This set of chasers would tear off the threads. Number 3 has too much lip, and while it would cut a good clean thread, it probably would cut a very wavy thread and would be apt to break because of the decreased cross section of the deeply ground lip. Number 4 has not enough heel and would strip off the top of the threads. It also has no lip, and would, on steel, only push off a chip, tearing off the threads completely and requiring much power to operate. Since it has no clearance, it would rub and heat.

In all threading, good lard oil should be used, or a suitable preparation for cooling and lubricating at the same time.

Leather Liner for Shop Anvil
Lessens Sledge's Rebound

A LEATHER liner between the shop anvil and the anvil block will lessen the rebound of the hammer, according to an old and experienced foundryman. The liner does not make the blows of the sledge any the less effective, but it does take off something of the sharpness of the upward rebound.

The most practical height for mounting an anvil is, according to the same authority, so that the top of the anvil comes to the level of the workman's fist when he is standing beside the anvil with his hand hanging naturally beside him. With an anvil so mounted, there is a minimum waste of energy.—A. L.



B.W. Cooke, Pres.

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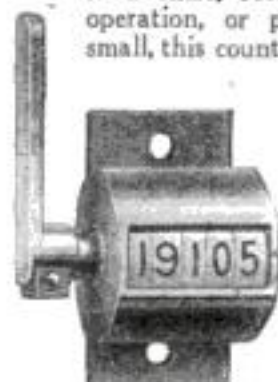
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If run backward the counter subtracts. Price \$2.00. (Cut 4/5 size.) Small Rotary Ratchet Counter, to register reciprocating movements of small machines, also \$2.00.

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Sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price with four figure-wheels, as illustrated, \$10.00—subject to discount. Cut less than one-half size. Set-Back Rotary Ratchet Counter, to record reciprocating movements as on punch presses, \$11.50 (Lst).

Whether you want to count production, packages or people, write for the new 80-page Veeder booklet; the right counter is there.

The Veeder Mfg. Co.,
44 Sargeant St., Hartford, Conn.

BETTER SHOP METHODS

Simple Threading Method Saves Time on Difficult Jobs

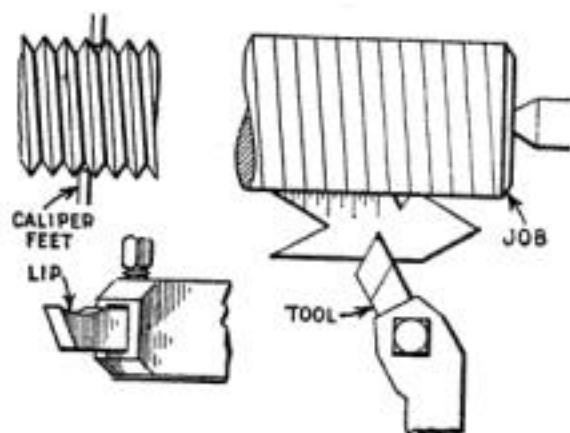
By Joe V. Romig

"THE rate on those piston rods and shafts stands just as it is, and not a cent more," said the night superintendent to the division foreman.

"Well, I'll try out another new man on the job tonight," the foreman answered. "You see, all of the old hands threaten to quit if I put them on that miserable threading job."

And so he put a new man on the old 30-in. lathe, which had been tooled up to turn out large compressor piston rods. Usually everything went well until the operators came to finish the thread on the cross head end of the shaft. This thread had to be a perfect fit with no play in a hardened gage, and had to spot up well on both sides.

The rate for both roughing and finishing operations was \$7 a rod, and one rod was the shop's record production for a good night's work, providing the operator had luck when finishing the threading. As all work had to be passed by the inspector



The type of tool used and the method of checking and testing the thread. Note the broad feet of the caliper

before a piece rate slip was made out for the operator, there was no chance of passing off imperfect work.

Out of the five men lined up at the time clerk's office, Frank was selected for the 30-in. lathe, and was taken over and shown the lathe, the job, and the print. The foreman explained the details, and asked Frank whether he thought he could handle the job. Frank wanted to know the rate for the piece, and when told, smiled to himself and asked where he could find the rough shafts. He plowed into his work and by midnight had the shaft ready for threading.

During the lunch hour, a neighboring machine hand made himself acquainted and told the new man the whole history of the miserable piston and rod job. He told him how hard and close the inspectors held one, and how at least six men had quit the job cold, as they could not make any money on it.

Frank was one of those who listen well and say little, but he thanked his informer. When the power started up, he ground a bit into a good, well-lipped roughing tool. After taking a first light cut, he checked the thread line, to see that all was set and correct in the lead, and then tore out good chips until the thread was roughed out.

Ignoring the offer of a spring tool holder from the hand across the aisle, he ground another tool, which he set in his left hand, solid tool holder, and proceeded to finish the thread. A finished shaft lay on trestles

(Continued on page 90)



Why they stick

On the ground floor of the telephone building a man worked at the test board. It was night; flood had come upon the city; death and disaster threatened the inhabitants. Outside the telephone building people had long since sought refuge; the water mounted higher and higher; fire broke out in nearby buildings. But still the man at the test board stuck to his post; keeping up the lines of communication; forgetful of self; thinking only of the needs of the emergency.

On a higher floor of the same building a corps of telephone operators worked all through the night, knowing that buildings around them were being washed from their foundations, that fire drew near, that there might be no escape.

It was the spirit of service that kept them at their work—a spirit beyond thought of advancement or re-

ward—the spirit that animates men and women everywhere who know that others depend upon them. By the nature of telephone service this is the every-day spirit of the Bell System.

The world hears of it only in times of emergency and disaster, but it is present all the time behind the scenes. It has its most picturesque expression in those who serve at the switchboard, but it animates every man and woman in the service.

Some work in quiet laboratories or at desks; others out on the "highways of speech." Some grapple with problems of management or science; some with maintenance of lines and equipment; others with office details. But all know, better than any one else, how the safe and orderly life of the people depends on the System—and all know that the System depends on them.



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Memo Pad

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- A Kellogg No. 609 radio resistance
- A Kellogg No. 502 dial
- A Kellogg No. 69A head set
- A Kellogg No. 501 rheostat
- A Kellogg switch and switch points
- A and B batteries and cabinet
- A Detector tube

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Write for our new booklet.



BETTER SHOP METHODS

Simple Threading Method

(Continued from page 89)

behind his lathe, and it was on this rod that the foreman had shown him what fit was required to pass inspection. Reaching over, he set his calipers and finished the thread to this size without trying the gage. Then pulling away the tail center, he tried on the gage, much to the wonder and amazement of the workmen around him, and called the foreman to see whether the fit was correct. With the job finished at 3 o'clock, both men and foreman knew that their new buddy was a real workman.

Later Frank explained his system of threading as follows:

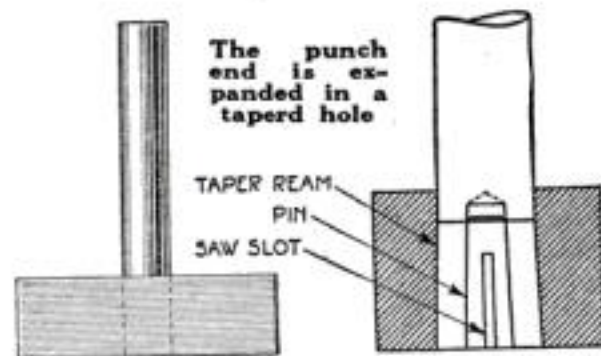
"Set your compound head at 30 degrees," he said, "and throw in your gear and screw and make a light trial cut, and check for pitch. Grind a roughing tool to cut only on the forward or left hand side, and rip out the thread with a few cuts. Since the tool is ground with a good lip, it will cut freely, does not tear like the usual tool, and makes heavier cuts possible.

"When the thread has been roughed out almost to size, change tools and finish down the right side of the thread with the flat side of the finishing tool. Upon reaching the bottom, change over and finish the left side of the thread on the sides rather than on the root diameter. This side, or pitch line measuring for diameter, is far superior to any other way in checking or measuring the diameter."

He used broad feet on his calipers, which bottomed on the sides of the threads as shown. In this manner, if a lathe hand has a perfect sample to go by, he can readily caliper the sides of the thread and duplicate the size on his own work.

Pin Fastens Piercing Punch to Its Holder

PIERCING punches are usually held with a setscrew, or the punch is headed over the end. I follow neither of these methods, but ream the punch holder with a



taper reamer for about $\frac{1}{4}$ in. from the back. Then I drill a hole in the end of the punch and slot the punch with a hacksaw, as shown.

A pin is driven into the hole in the punch to expand the end, so that there is no chance of the punch's pulling out.—S. L. ROBERTS.

Length of Rolled Belting

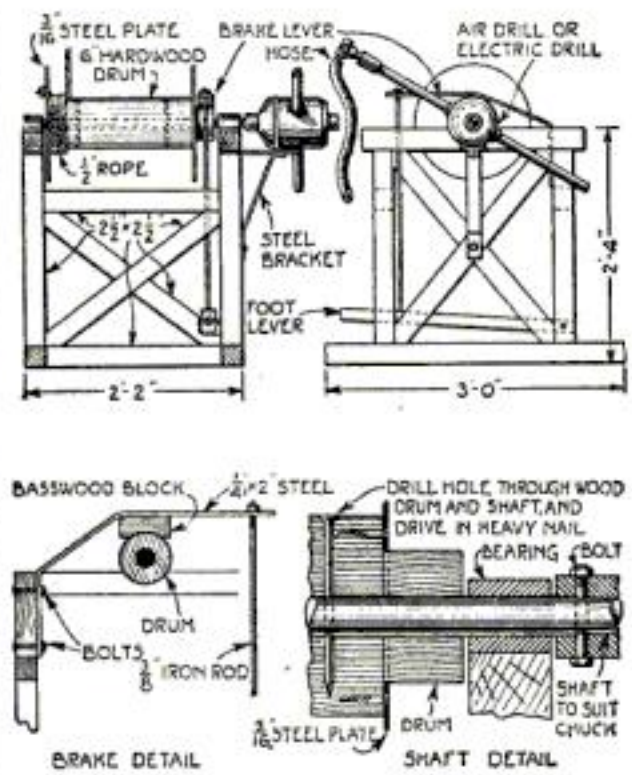
TO COMPUTE the length of a roll of belting, measure the distance from the outside of the roll to and past the center as far as the first inside turn; in other words, the radius of the roll, plus the radius of the central hole. Then multiply by the number of turns and multiply the product by .2618.—J. H. MOORE, Toronto, Can.

BETTER SHOP METHODS

Winch for Light Work Operated by Air Drill Motor

FOR hoisting corrugated steel we use a winch operated by an air drill motor, although an electric drill motor would serve the purpose just as well. The winch was built because the hoisting engine is usually occupied with heavier and more important work.

The method of mounting the drum and motor, constructing the bearings, and arranging the brake are sufficiently illustrated

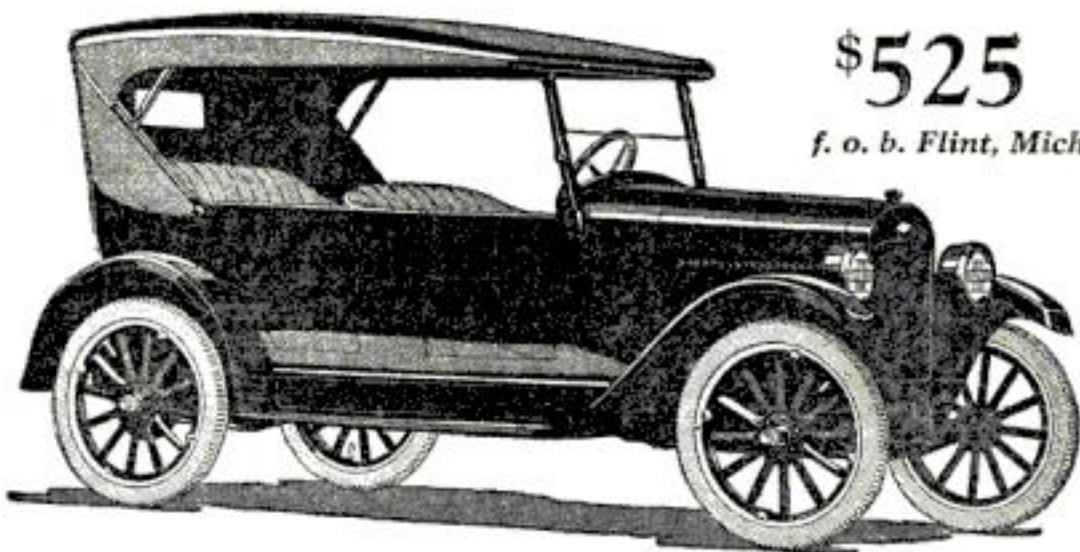


Front and side views of the winch and details of the brake and shaft

in the accompanying details. If an ordinary air motor is used, a three-way cock should be placed at the connection to the air hose and opened to the atmosphere when the rope is being lowered. This will relieve the back pressure and allow the rope to descend much more rapidly. Should a double-acting air drill be used, however, the three-way cock will not be necessary.—HERBERT A. STRICKLER, Buffalo, N. Y.

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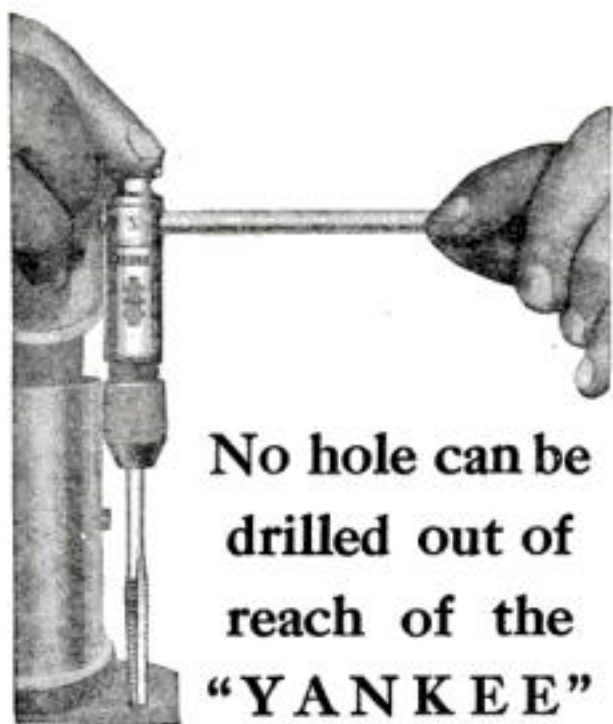
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The Home Workshop

(Continued)

Colonial Desk Richly Repays Building

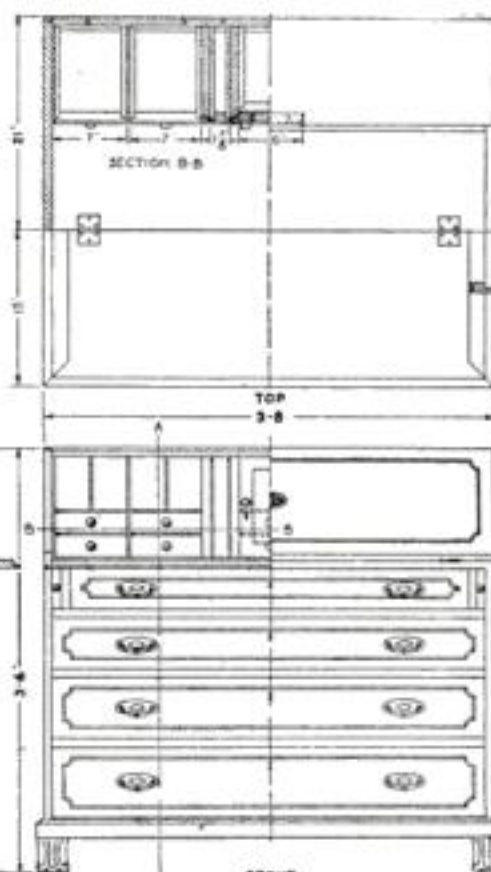
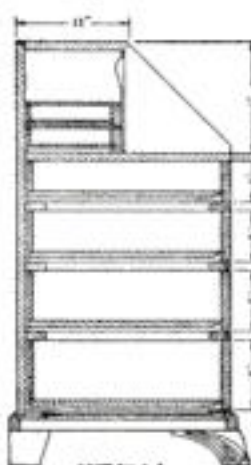
NO DESK will look better in your home than the Colonial writing desk illustrated at the right. Combining utility with beauty to a superlative degree, it is the type of furniture that becomes more attractive as age deepens the color of the wood, and the polishing of long usage makes the surface richer and more varied in tone.

Designed after a genuine antique of especially fine proportions, this desk is 3 ft. 6 in. high, 3 ft. 8 in. wide, and 21 in. deep. The drop leaf is supported by two pulls.

There are four large drawers and ten small ones, two of the latter being concealed behind the door of the "safe" compartment in the upper case. Alongside this compartment are two narrow, vertical document cases with blind fronts that make them, when properly fitted, quite inconspicuous. These can be fitted with secret locks if the builder wishes.

Solid mahogany is used for the visible parts and whitewood or other inexpensive stock for the unseen portions of the frames and drawers. Although the details follow the Colonial construction in the use of solid stock throughout, three- or five-ply veneers can be substituted for the drawer bottoms and elsewhere.

The inlays add largely to the beauty of the desk but can be omitted, if it is not wished to spend the time necessary to apply them. The front feet can be carved with very little difficulty, and there are two ways of doing it. The easiest is to rough out the feet approximately to the shape shown and then carve them by



Details of writing desk based on one of the simplest and most beautiful Colonial models. Home Workshop Blueprint No. 21 contains the complete bill of materials

hollowing with a gouge. The other is to carve them in high relief so that the curves are rounded out instead of in.

The hardware should be brass or bronze and Colonial in design.

A desk such as this deserves to be French polished by a professional, but good results can be obtained by the amateur if the inlays are shellacked, the wood stained with dark mahogany, and six or more coats of very thin orange shellac rubbed with pumice, rotten stone, and oil.

A complete bill of materials and the more important constructional details are contained in Blueprint No. 21 in the Home Workshop series.

THE HOME WORKSHOP

will fit into $\frac{3}{8}$ -in. grooves in the rails and stiles. The frames are screwed to the back and are fastened to the front stiles either by tongue-and-groove joints or butt joints secured with small finishing nails. Either dovetailed or mortise and tenon construction can be used.

The back has two narrow panels $10\frac{1}{4}$ by $24\frac{1}{8}$ in. and one large central panel $16\frac{1}{4}$ by $24\frac{1}{8}$ in. The construction of the front is made clear in the illustration. The boards are 11 ft. by 2 ft. 2 in.; panels $9\frac{3}{4}$ by $22\frac{5}{8}$ in.

Each pedestal contains a locker with shelves, although sometimes it is worth while to make drawers, as shown in the circular insert. When space is at a premium, close up one of the compartments in front and leave it open at the end for book shelves, as shown in the other insert. The front of the shallow drawer in the center is 3 by 20 in.

Complete details of this desk and a bill of materials are contained in Home Workshop Blueprint No. 20.

Combination Desk, Cabinet and Book Rack Occupies Small Space

BY THE use of wallboard panels, the construction of the combination cabinet, writing desk, and book-rack, shown on page 94, is simplified and the cost materially lessened.

The desk was designed with the needs of a high school or college girl in mind. For her use it is particularly appropriate, but it will prove serviceable in almost any home.

The construction is most ingenious, so that the desk can be made with the fewest possible tools and in the simplest way. It is really made in three parts bolted together, and it can be taken apart for convenience in moving about.

The sliding desk top has strong, neat, smooth-working slides made by screwing two strips of flooring to the sliding

(Continued on page 94)

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Popular Science Monthly
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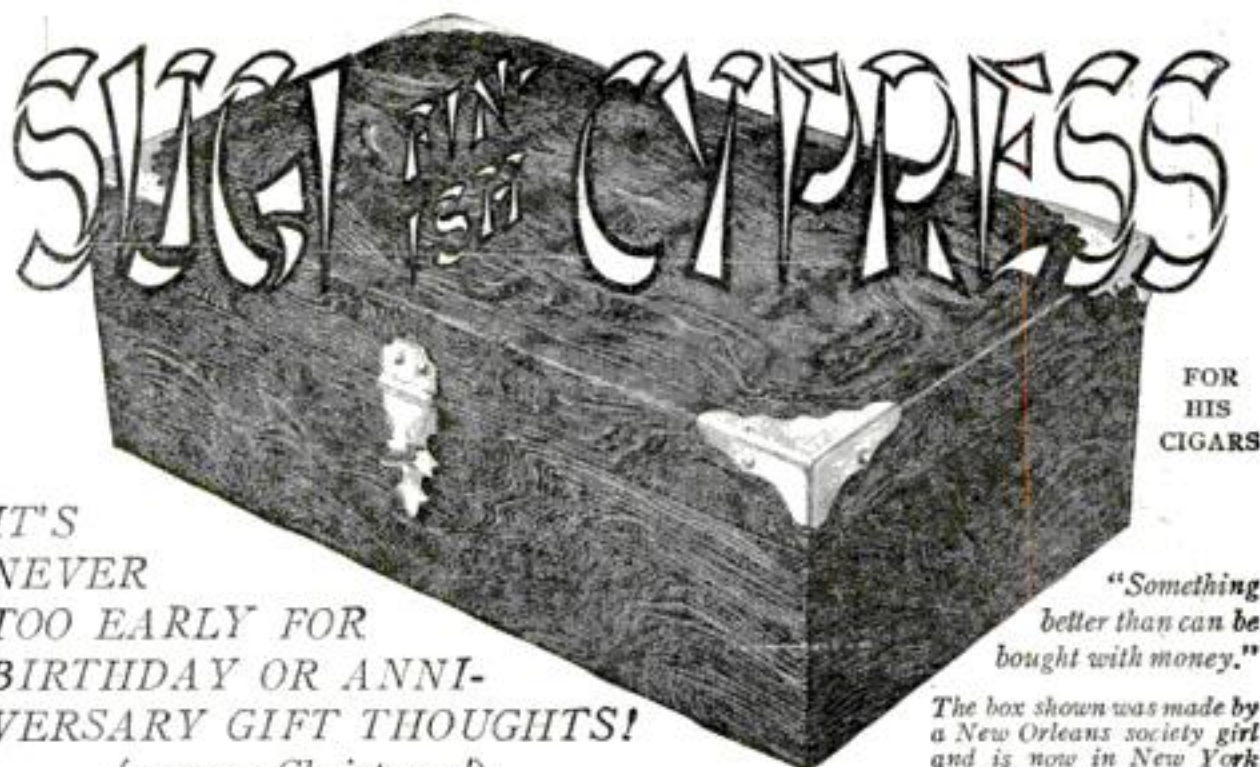
Send me the blueprint, or blueprints, I have checked below, for which I inclose.....cents in stamps or coin:

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THE HOME WORKSHOP

Combination Desk and Cabinet

(Continued from page 93)

top in such a way that the tongues fit into grooves of two other strips of flooring screwed to the frame that connects the two cabinet ends.

The end sections are made high so that clothes may be hung in them if there is a shortage of other closet room, in which case two light rods should be suspended from the tops of the compartments to support skirt and waist hangers. Any arrangement of shelves, compartments, or even drawers can be worked out to suit the needs of the person who is to use them. Either doors or curtains may be used to close the end sections.

The general method of construction is the same as if wood panels were used, ex-



cept that the plowed grooves must be made to suit the thickness of the wallboard. Both the outside ends are made alike and the two inside partitions are alike.

The ornamental strip or apron on the under side of the front of the sliding top serves as a handle by which to pull it out and at the same time conceals the frame that supports the guides.

The book-rack is made separately and screwed in place at the back of the writing top, just far enough above the sliding top so that the latter can pass underneath.

In assembling the cabinet, the two under sections are placed about the correct distance apart, the connecting frame is slipped into place, and four bolts are tightened to draw the whole firmly together.

The outside dimensions are as follows: Full width, 3 ft. 4 in.; width of ends, 1 ft.; width of center section, 1 ft. 4 in.; height at ends, 2 ft. 10 1/2 in.; height at center, 2 ft. 5 in.; depth, 1 ft. 8 1/4 in. The sliding top is 16 by 20 in., and the cabinet tops are 13 3/4 by 22 in.

By actual test wallboard has proved to be an excellent material for panels of this kind. The possibilities of decorating it are almost unlimited. It can be obtained in several different finishes, and many varieties can be painted. This permits the use of stenciled ornament.

If the woodwork is oak, a particularly effective finish is obtained by staining it dark oak, painting the panels a soft gray green, rather light in tone, and stenciling or painting freehand the decorative spots or lines a rich dark red, somewhat grayed, with perhaps a few small contrasting touches of green, a little lighter and brighter than the background color of the panels.

The working drawings of this piece of furniture form the subject of Blueprint No. 22 in the Home Workshop series.

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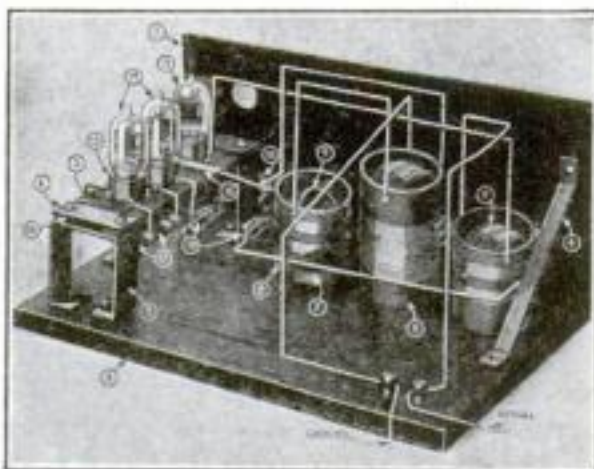
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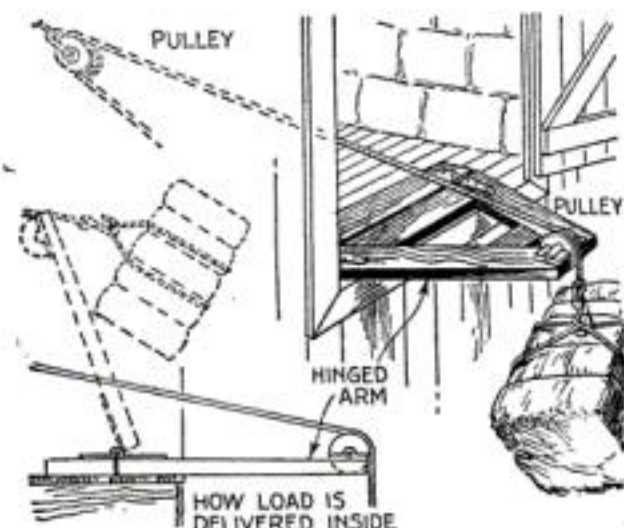
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THE HOME WORKSHOP

Hinged Arm Delivers Hoisted Load within Barn

A HINGED extension supporting the hoist rope, as illustrated, is a practical means of lifting hay and other supplies to a barn loft or other structure. It serves the purpose of the usual bolted arm that ordinarily supports the pulley when the load is being lifted, in that it keeps the



When hoisted, the load swings automatically into the loft

load clear of the wall, but the real advantage comes in delivering the load.

After the load is drawn to the full height of the pulley, a further drag on the hoist rope picks up the load and carries it inside the door. This saves time and eliminates the danger of accident caused by reaching outside to draw in the load.—A. C. P.

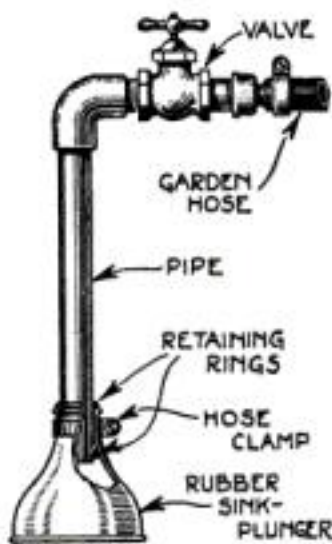
Cleaning Polished Furniture

NEVER wash fine varnished furniture with soapy water. The alkali in the soap will in time damage the finish.

A good wash for even the finest French polished furniture is 2 tablespoons of crude sulphuric acid and the same amount of paraffin in a pint of water. Shake well before using, and wash the surfaces lightly and evenly, a small part at a time, drying immediately.

Cleaning Clogged Drains with Water Pressure

WHEN difficulty is experienced in keeping drains from becoming clogged, a simple device may be constructed in the home workshop to utilize water pressure in keeping them open. It consists of short lengths of pipe, a valve, a length of garden hose, and a rubber sink-plunger connected to one end of the pipe with a hose-clamp.

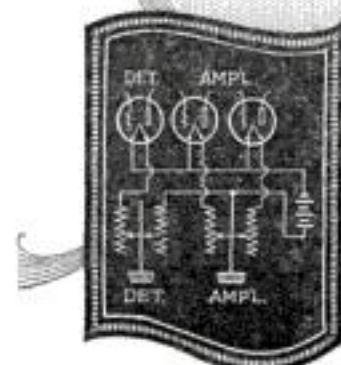


Method of connection

In use, the plunger is applied to the drain opening so as to get as tight a joint as possible, and the water is turned on. The pressure will flush the clogged trap and clear the drain unless the obstruction is exceptionally deep seated.—C. F. GRIMM.

A Big Stride forward

The Autostat A Super Rheostat



Can be used with 6-Volt or WD 11 Detector Tubes, two Amplifying Bulbs, or one 5-Watt Power Tube.

THE AUTOSTAT presents an entirely new principle in filament rheostat construction and radio takes another BIG step forward.

No longer is it necessary to turn a "hair's breadth" to tune in that elusive station, for with the AUTO-STAT you can give the knob a substantial turn and get a superfine adjustment. No other rheostat to date possesses the necessary "fineness" of adjustment to eliminate interference and "tube howls" under all conditions. But the AUTOSTAT, with its micrometer adjustment, will positively give these much-sought-for results.

How It Works

Two parallel mounted resistance tubes are connected in series by a "micrometer-operated" slider—the length of wire in circuit depending upon the location of this movable slider. Forty turns of the AUTOSTAT knob are required to complete the variation from minimum to maximum resistance—against one-half to three turns on others.

This exclusive patented construction means:

1. One full turn of AUTOSTAT knob produces finer tuning than a "hair's breadth" turn on any other.
2. Economical—only two AUTOSTATS required for a three-bulb set.
3. Greatly increased receiving range and clearness of signals.
4. A uniform change in resistance with each turn of the AUTOSTAT knob.
5. Indestructible wire-wound fireproof lava resistance element.
6. Unqualifiedly guaranteed.

Popularly priced, \$1.35

Dealers

The AUTOSTAT will be nationally advertised. And all HOMCHARGER dealers and jobbers know that when we say "advertising" we will dominate the field and convert their stocks of AUTOSTATS into cash QUICKLY and PROFITABLY.

AUTOSTATS come in neat individual boxes, which, in turn, are packed in "business-getting" display cartons—with plenty of live dealer helps, and discounts that net real profits.

Order a carton of AUTOSTATS from your HOMCHARGER jobber TODAY—be the first in your locality to "cash in" on what is destined to be radio's fastest-selling filament rheostat. If he can't supply you, write us direct.

Jobbers

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Just dreaming alone won't do. Hitch your dreams up to facts and you will go far. You will get the facts through special training along the line in which you want to succeed. And the place to get just that training is the American School. This is proven by the quarter of a century of successful experience we have in helping many thousands of men and women gain an enviable place in business and social life. Another reason why the American School is the place to get your training—it is not a business corporation but a Chartered Educational Institution, incorporated not for profit. Space here is too limited to tell you of all the advantages you will gain by getting your training from the American School, but the coupon will bring you full information and a descriptive book, without cost or obligation to you. Fill out and mail the coupon NOW, while you are thinking about it. No agents will bother you.

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|Accountant and Auditor |Sanitary Engineer |
|Bookkeeper |Surveyor (& Mapping) |
|Draftsman and Designer |Telephone Engineer |
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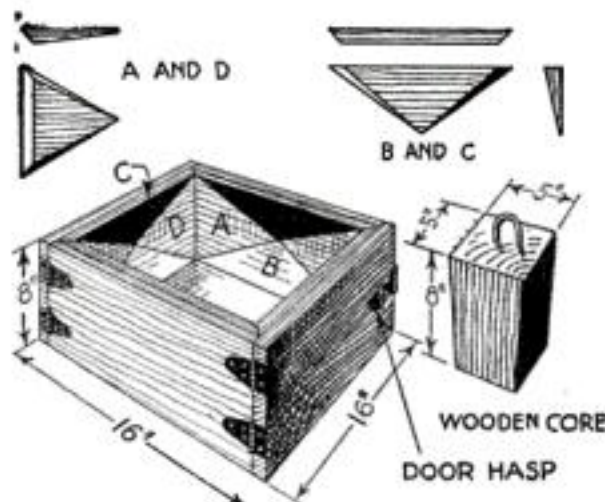
THE HOME WORKSHOP

Ornamental Concrete Blocks Quickly Cast in Wooden Mold

By Dale R. Van Horn

WHEN a few concrete blocks other than commercial sizes are required for masonry work about the home, shop, or farm, it is often possible to cast them quickly and easily in a wooden mold. The mold illustrated is one used by a landowner who wished to add substantial yet attractive gateposts to a drive and to build four corner posts for a lawn fence.

Two 1-in. boards 8 by 16 in. and two 8 by 14 in. were used for the outer forms. The pieces were fastened together with hinges, except at one corner, which was provided with a hasp and staple. The mold proper was made of 16 triangles. Eight of the shape marked A-D were 8 in. long and 7 in. high. The 8 like that marked B-C were 14



Triangular shaped pieces are applied to the inside of the mold to give the cement blocks an ornamental appearance

in. long and 4 in. high. Each piece was planed down from a full size 1-in. thickness at the base to $\frac{1}{8}$ in. at the point. They were nailed to the outer form with finishing nails, care being exercised not to mar the surface in any way. The vertical edges were mitered to fit at the corners where the form was closed.

A core was made from a block 5 in. square and 8 in. long, with a $\frac{1}{4}$ -in. iron rod bent U-shaped to serve as a handle. The sides of the block were tapered to 4 in. square at the bottom to facilitate its removal.

The mold was set on a smooth surface and filled with mortar after the core had been put in place. The mortar was tamped down well and smoothed off on top. The hasp was then unlocked and the sides swung away from the green block.

The same principle may be used for producing various types of blocks and faces. For instance, a good cobblestone effect can be obtained by using a lining of four sheets of galvanized iron dented irregularly with a ball-peen hammer. Wooden strips can be used for producing panel effects.

Giving the mold two or three coats of varnish or thoroughly oiling or greasing the inside is recommended but not necessary. If not done, at least wet the mold thoroughly before placing any concrete in it.

Testing Sand for Concrete

WHEN mixing concrete, be sure that the sand you are using is of good quality. Test it by stirring a little in a glass of water. If it leaves the water clear in settling or with little discoloration, it is usually excellent for use with cement.

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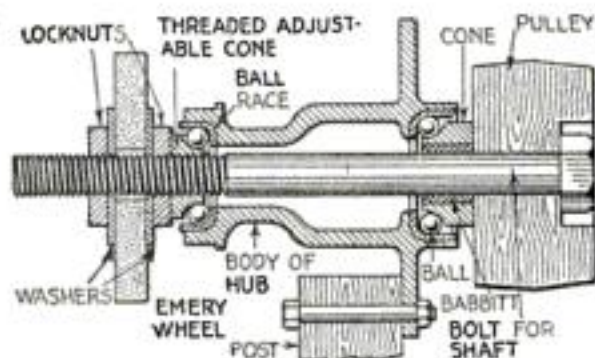
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THE HOME WORKSHOP

Automobile Front Wheel Hub Forms Bearing for Grinder

A GRINDER with ball bearings that will give much better service than one mounted in makeshift bearings made from pipe fittings, can be assembled cheaply from a discarded automobile front wheel hub. A bolt is used for the mandrel and a block of wood for the pulley.

The necessary parts usually can be picked up from the scrapheap, and the only cost is in having the bolt threaded to suit the outside cone and locknut. To assemble the



Sectional view of the hub, fitted with a bolt for a spindle and a wooden pulley

grinder, the pulley is made fast to the bolt, the large cone is then slipped over the bolt and centered squarely, and Babbitt metal is poured into the space between the bolt and the cone. The parts are then assembled as a regular axle spindle, with the exception that two large washers and an extra nut are used to clamp the emery wheel, saw, or other wheel.

The post or pillar for mounting the mandrel may be an upright plank with one large hole and several smaller ones to suit the holes in the hub. After the stand is mounted, a small rope can be wrapped around the wheel end of the bolt by a helper and used to turn the mandrel, while the builder of the machine trues up the pulley with a chisel or gouge held against an improvised tool rest.—F. R. KIEDINGER, New Orleans, La.

Shipping Case for Pictures Has Rubber Shock Absorbers

THE shock absorbing shipping case illustrated is one I designed for valuable pictures. It meets all the requirements of modern transportation and is being used by one of the largest advertising firms in the world.

A standard case is built around the picture or object to be shipped. Heavy rubber



The picture is suspended by strong elastic bands, twisted tight by means of screw-eyes in the case

bands are fastened to the case and to the frame or to blocks attached to the frame or other article. The screweyes used for this also serve as turnbuckles to tighten the rubbers. The method is especially useful for shipping pastel and charcoal drawings.

—WALTER S. J. THOMPSON, Brooklyn, N.Y.



When every hour counts

BILL wanted to make his radio set as quickly as possible. But at the very beginning there was a delay in getting his panels. It wasn't a long delay, but he was impatient and wanted to make every hour count.

You, Bill, and every radio set-builder can avoid such a delay by getting Celoron Standard Radio Panels. You don't have to wait for your panel to be cut. There's no extra expense for cutting to your order. You go to your dealer and give him the size. He has a Celoron panel which you can carry home with you at once.

Each panel comes trimmed and wrapped separately in glassine paper to protect the surface. On each one are full instructions for working and finishing.

Celoron makes an ideal panel. It is easily worked, machine drilled and tapped, and will engrave evenly without feathering. It has high surface and volume resistivity, high dielectric strength and low dielectric losses.

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| 3.—7 x 12 x $\frac{1}{8}$ | 6.—7 x 21 x $\frac{3}{16}$ |
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Make every hour count in making your radio set. If your radio dealer has not yet stocked these panels, ask him to order for you. Or write direct to us. Be sure to designate by number the size you want.

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The Red Seal Radio Sparker is especially designed for operating the W D-11 dry battery tube. For instance, a 2-cell Radio Sparker will give longer service—nearly 3 times longer than a single cell. Radio Sparkers are specially designed for radio use. Connections between cells are soldered insuring perfect contact. Remember the name—Radio Sparker.

The New Manhattan Genuine Bakelite Line

In the new Manhattan Variometer and Variocoupler, Genuine Bakelite gives highest insulation and freedom from mechanical troubles. The amount of metal used has been reduced to a minimum, electrical losses are therefore low. A Bakelite mounting block permits installation on metal panels. Heavy "pig-tails" insure positive contact and quiet operation. Variocoupler gives complete control up to 700 meters. Variometer has wave length of 170 to 490 meters.

Manhattan Bakelite Knobs and Dials—precision, quality, perfect alignment, extremely fine clear engraving.

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It has a heavy, moisture-proof steel container. Withstands roughest usage and delivers a hot, dependable spark. A perfect battery for ignition uses.



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THE HOME WORKSHOP

Powerful Radio Set for the Loudspeaker

"MY SET doesn't give enough volume on the loudspeaker," is the complaint of many radio fans with two-stage receiving sets.

Usually they hesitate to add another stage of audio frequency, because it is commonly supposed to introduce noises that make clear reception difficult. But the results of considerable experimenting have convinced me that a well designed three-stage audio frequency set will bring in, without noise or distortion, stations within a radius of 500 miles, so that they can be heard clearly with a loudspeaker, and stations within 200 miles loud enough to provide music for dancing. The set illustrated does this regularly and has the further great advantage of

tube is 4 in. in diameter and 3½ in. long. The two rotors are held in position, as shown, by four bearing pieces of ⅜ by 1/16 in. brass. Each piece has one ¼-in. hole drilled ¼ in. from one end for the shaft and two holes at the other end for fastening it to the stator tube.

The distances between centers of the shafts of the rotor tubes should be such that the rotors will not touch each other as they are rotated. A coiled spring is wound

Designed and built by the Radio Editor of Popular Science Monthly, this three-stage set gives exceptional volume of tone on the loudspeaker and is free from the noises and annoying capacity effects noticeable with much apparatus not properly constructed. Note the compact, homemade tuning unit and the few controls.



around the rear end of the shaft of the rotors so that its pressure will keep the rotors at any position in which they may be placed. Washers are inserted at the front of the shafts to center the rotors with respect to the stator tube.

To anchor the rotor windings,

two screws are used, as shown, and one end of the winding is soldered to one screw and the other end to the other screw. Two insulated flexible wires are then soldered to the screws and led to the outside through the hollow ¼-in. rotor shaft and fastened to screws put through the stator tube. The connections leading to the other instruments are taken from these points.

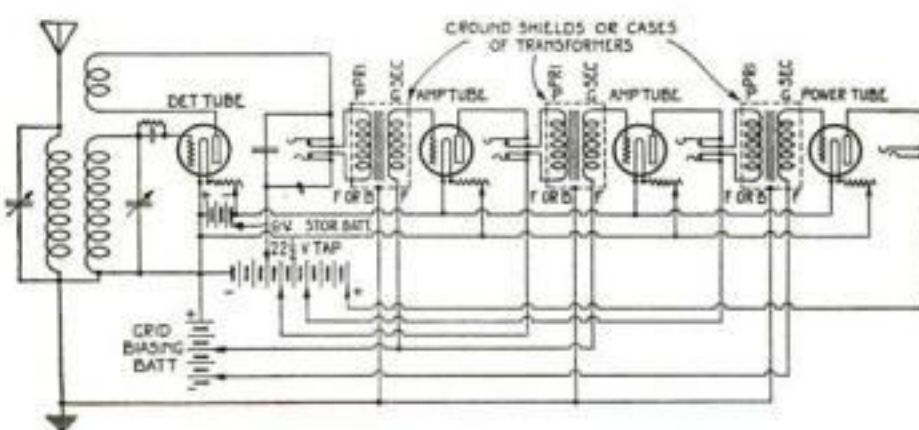
The rotors are prevented from being

being simple to operate and not very much more expensive to assemble than an ordinary two-stage set. It is not critical in tuning and yet gives high selectivity.

This set in New York with a 55-ft. single wire aerial stretched along the edge of the flat roof of a three-story house, brings in Davenport, Ia., so as to be clearly understood on a loudspeaker that has no battery. The distance is about 900 miles.

All the set, except the batteries, is mounted on a 12 by 24 in. board. The homemade tuning unit, illustrated in detail on page 99, is so constructed that the 360- and 400-meter stations are brought in merely by the action of a 7-plate primary variable condenser.

The composition or hard rubber primary



Hook-up of the set, which employs a detector tube, two amplifying tubes and, for the last stage of amplification, a power tube

THE HOME WORKSHOP

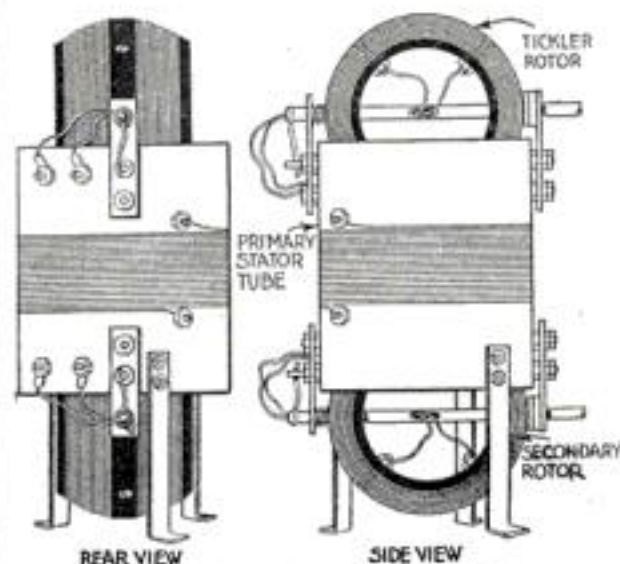
turned through more than 360 degrees by soldering a stiff piece of heavy wire to the rear end of the rotor shaft, as shown, the rear outside screws through the bearing pieces being left long enough to serve as stops.

In mounting the bearing pieces, the holes for the screws are countersunk slightly on the inside of the stator and flat head screws are inserted with the heads on the inside. The screws are held in place by nuts on the outside, placed between the stator and the bearing pieces. The bearing pieces are fitted to the rotor shaft, so that it will turn freely, and mounted in place. When mounted, the rotors are centered correctly, and the outside nuts are placed over the bearing pieces and tightened.

The primary should be wound with 30 turns of No. 20 or No. 22 single or double cotton or silk covered wire and the ends anchored, as shown. The rotors are then mounted.

To fasten the rotors to the shaft, all that is necessary is to flatten the part of the shaft that fits into the solid part of the rotor so that the cross section at that point is slightly elliptical. The shaft can then be forced into the rotor to make a firm force fit and hold the shaft and rotor together without the necessity of keys or pins. The top rotor is used as the tickler coil, while the lower rotor is the secondary coil.

A 5- or 7-plate variable condenser is used as a primary condenser, while an 11- or 23-



Details of the tuning unit, which consists of a stator tube with fixed primary winding and two rotors

plate condenser serves as a secondary condenser. Condensers with more plates can be used, but those mentioned will give closer tuning and, consequently, better results. Condensers, rheostats, and jacks can all be board mounted if small angles of suitable size are made of $\frac{3}{8}$ by $\frac{1}{16}$ in. brass or other strip brass, drilled and bent as required.

Much of the howling and other noises heard in receivers are due to faulty wiring and location of the parts. You will notice that the tube sockets in this set are not placed in one straight line, but staggered, and that this makes it possible to increase the distances between the transformers. These distances are also slightly increased by mounting the second transformer on a sort of elevated platform. This separates the fields of the transformers from each other so that their effect upon each other is reduced to a minimum.

The terminals are placed so that the grid leads are as short as possible. The shorter these grid leads are, the less will be the chances of the howling effect frequently
(Continued on page 100)

"My Vitalics Still Good After 6 Years Use"

I have had one set of Vitalic Tires on the first and only bicycle I ever owned. It was bought in 1917. The tires were on the bike then, and they have never been taken off except when the bicycle was being repaired. I have been over every kind of road—mud, sand, rock, cobble, concrete, and macadam. The best part of this story is that I have never had a puncture. The tires are just beginning to show signs of wear after almost six years of faithful service.

Alvan R. Kirk
Nelson St.
Springfield, Ma



ALAN KIRK'S experience is typical of what all boys and men say who ride on Vitalic Bicycle Tires. But it's the sort of evidence that counts most with the buyers of tires—and it is proof of the wearing, lasting qualities that are put into all Vitalics. For real endurance, freedom from punctures, for the things a bicycle rider wants most from his tires, there is nothing to equal Vitalics. And when such makers as Excelsior, Iver Johnson and others insist on Vitalics as standard equipment for their finest bicycles, is there any wonder boys for years have preferred them. Thousands of boys have proved for themselves the truth of the slogan "Tougher than Elephant Hide."

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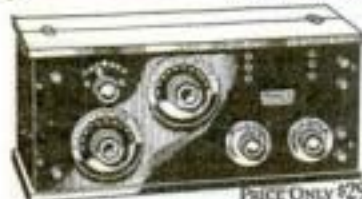
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Dept. B109 Chicago



THE HOME WORKSHOP

A Powerful Radio Set

(Continued from page 99)

due to the plate currents being fed back into the grid circuits.

In wiring the set, start with the filament circuit and run the wire from the A battery terminals shown to the extreme right in the front view on page 98. The wire from the front terminal connects one terminal of each rheostat, while the wire from the other terminal connects one terminal of each tube socket. The free terminals of each rheostat are then connected to the free filament terminals of their respective tubes. Care should be taken that as few wires as possible run parallel to each other. All connections should be soldered wherever possible.

The wiring diagram will show you that use is made of a grid biasing battery, the correct value of which is found by experiment. This battery may be made by connecting several flashlight cells in series or a small 22½-volt B battery can be used by connecting the positive 22½-volt terminal to the negative of the B batteries and attaching the secondary F terminal of the transformers to the other positive variable taps. In some transformers one terminal of the secondary is marked F, while in others it is marked B. Where no marking is found, this terminal is the inside end.

A soft detector tube is used as a detector, standard amplifier tubes are used in the first and second stages, and a power tube is used in the third stage. While not absolutely necessary, the use of a power tube in the third stage gives much better results. While the usual power tube can be used with a 6-volt storage battery, the maximum efficiency is obtained with an 8-volt one.

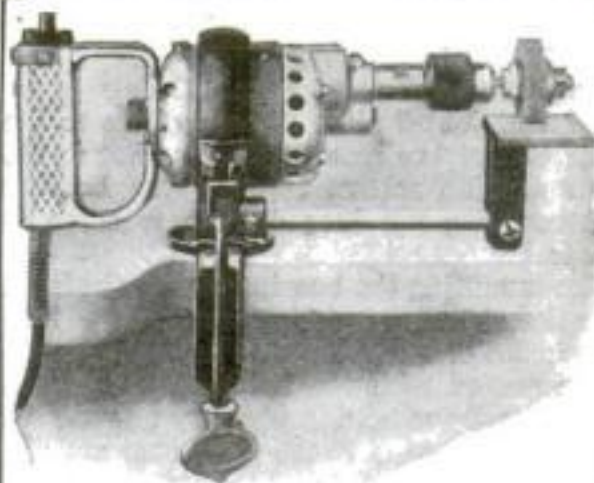
The plate voltage on the detector should be about 22 volts; on the first and second stage tubes, from 45 to 100 volts, and on the last stage from 100 to 300 volts.

The negative bias on the first two amplifier tubes can be adjusted at the same time, the two secondaries of the transformers being connected together. This voltage will vary from 1½ to 6 volts, while the negative voltage on the last tube may vary from 3 to 20 volts.

The tuning of the set is simple. By turning up the filament until a rushing sound is heard and varying the primary, secondary and tickler adjustments, the characteristic whistle is heard. The controls are then manipulated until the zero beat adjustment at the lowest pitch of the whistle is found on each adjustment. In order to minimize further any possible chance of howling due to the interaction of the transformer fields, a wire should be connected to the cases or framework of the transformers and then grounded. Grounding the lead that goes from the secondary of the tuning unit to the A battery also has the effect of stabilizing the set and preventing possible noises. In connecting the condensers, the rotary plates should go to the grounded side of the circuit, in order to avoid any capacity effects when making adjustments.

Care must always be taken that the A battery is fully charged and that the B batteries are in good condition.

If you have alternating current in your home, the best investment you can make is to install a battery charger so that you can keep the battery fully charged all the time. The cost of charging the battery at home is less than one fifth what you would have ordinarily to pay to get it charged at the service station.—THE RADIO EDITOR.



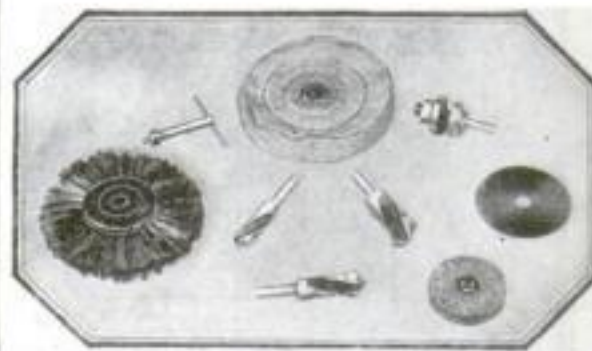
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THE HOME WORKSHOP

Old Electric Light Bulb Is Dependable Weather Man

A WEATHER forecaster of unusual but almost absurdly simple construction can be made from an old electric light bulb. Immerse the bulb in water that has been colored with a few drops of red ink and clip off the tip under water with a pair of pliers. The liquid will then fill the bulb and remain in it when the lamp is lifted out.



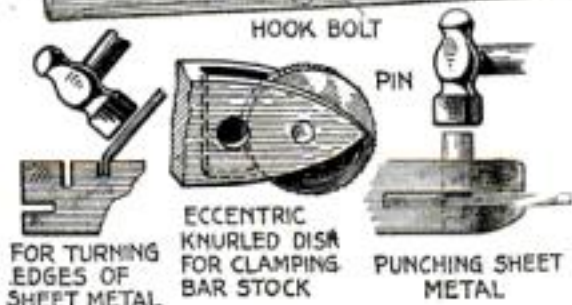
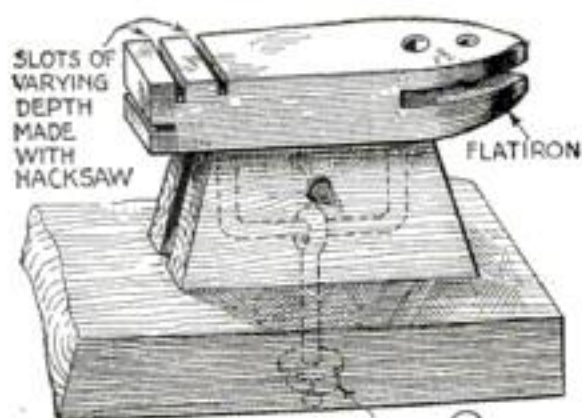
Spot on blotter indicates falling barometer

Hang it up as shown by tying a piece of cord or bending a length of wire around the threads of the base. Beneath it place a clean blotter.

A decrease in the barometric pressure will cause a drop of the liquid to ooze out at the tip and drop to the blotter. Hence, whenever there is a spot on the blotter, one may expect rainy or stormy weather. It is advisable to make this contrivance when the atmospheric pressure is high.—A. J. D.

Flatiron as Useful Bench Fixture and Anvil

THE home worker can provide himself with a serviceable anvil and bench fixture for light work by rigging up a heavy flatiron as illustrated. It is mounted be-



Slotted, drilled, and mounted, a flatiron serves for much light metalwork

tween two blocks and fastened to the bench by means of a hook bolt fastened around the handle and drawn tight from beneath.

Slots of various depths can be cut in the top surface and at one end to serve for turning the edges of sheet metal, and the point can be used as a punching fixture for clamping bar stock, and the like.—G. A.



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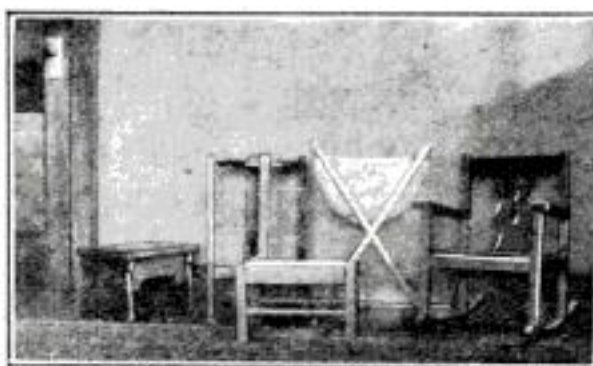
THE HOME WORKSHOP

How I Make Money Converting Scrap Lumber into Furniture

MY EXPERIENCE in making furniture in my spare time has shown that it is a profitable pastime. If good judgment is used in the purchase of materials, any one who is handy with tools should net about 30 cents an hour for the time actually spent at the bench.

I have found the field for doll furniture particularly good. Every sale brings new customers and when one article is sold, the buyer usually wants other articles to complete the set. In my work I make use principally of odds and ends of waste material left over from housebuilding, such as pieces of base, trim, flooring, lath, sheathing, siding, wood veneer, and even packing boxes.

Before the holidays I disposed of much children's and dolls' furniture such as cradles, high chairs, dining-room sets,



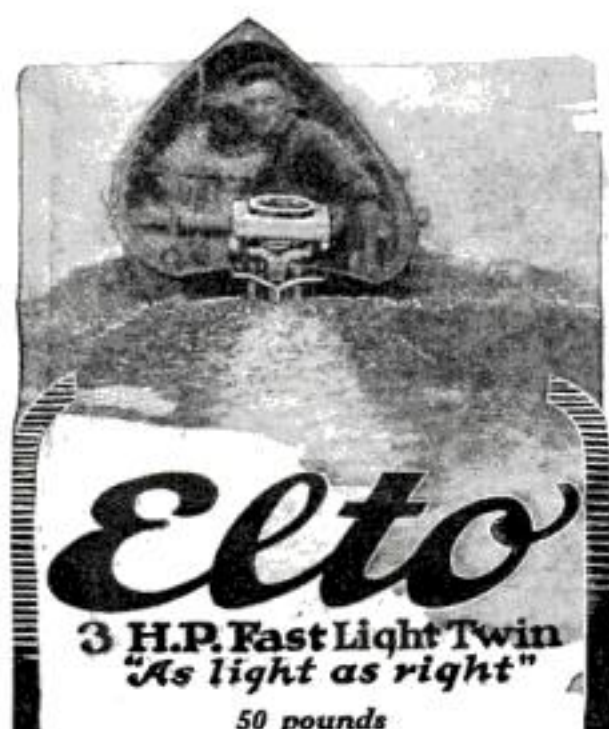
Play furniture for children, the size of which can be estimated by comparison with the door at the left

kitchen cabinets, rocking chairs, and beds. In the better class furniture I have made telephone stands, costumers, footstools, plant stands, sewing baskets, and window boxes.

On the whole, a line of small furniture is easily manufactured and sells at a better profit, I find, than the higher grade of furniture. It is not necessary to be a mechanic to make pieces such as those illustrated. For instance, in the case of the chair, the rungs are nailed through with small finishing nails or brads, the seats are fiber purchased at a five and ten cent store, and the slats are waste lath dressed to size. The finish consists of turpentine or gasoline and asphalt, burnt umber, drop black or other suitable colors, with a cheap grade of varnish. I find it pays to watch the toy catalogs for attractive designs and select ones that promise to be best sellers. Then I make a sample and perfect it as far as possible. This I dismantle, using it as a pattern for making a dozen or more like it.—JOHN BUTCHER, Niles, Mich.

A Way to Start Small Screws

TO START into their holes tiny screws such as are used in watches, clocks, and other small mechanisms is often difficult, because it is next to impossible to hold them with the fingers when setting them in place. This difficulty is easily overcome by forcing the screw through a small strip of paper and using the paper as a handle for setting the screw while starting it with a screwdriver.—C. J. WATTERS.



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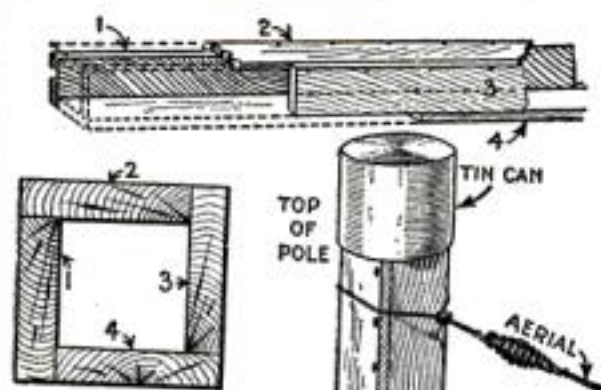
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THE HOME WORKSHOP

Tall Aerial Mast Is Built with Interlocking Wooden Strips

THE writer has had in use for some time an antenna pole 35 ft. high made of wood as illustrated. Despite poor material and indifferent workmanship, it withstands high winds, is apparently in good condition, and supports my aerial at an enviable height. The mast combines lightness and strength, because regardless of what side the strain comes, the pull is always against the grain of some part of the wood.

Wooden strips approximately 1 by 2½ in. by 7 ft. are used. Old packing crates will provide material, or rough, unfinished strips from a lumber yard can be bought. The number required depends upon the length of the strips and the height of the pole desired. For a 30-ft. pole 20 strips will



How the strips are nailed together to form a strong box and the way the top is capped

suffice, even if parts of some of them are discarded because of knots and defects.

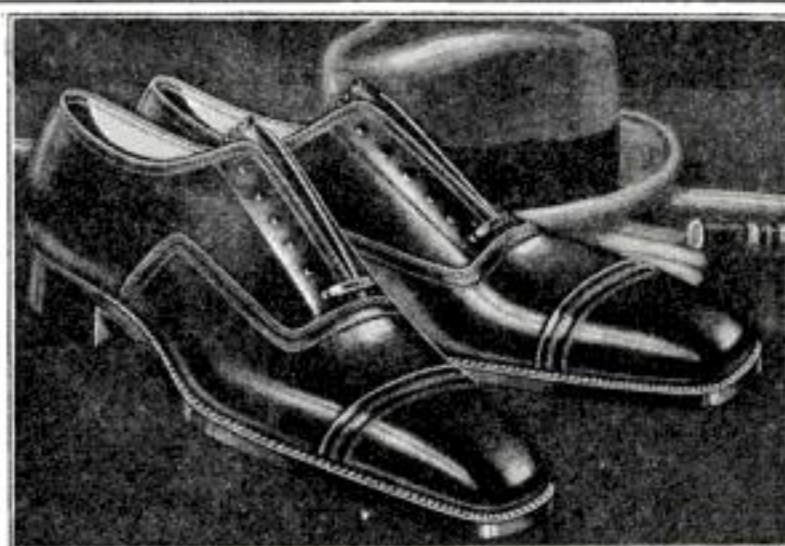
The order in which the strips are nailed to each other is shown by the numbers 1, 2, 3, and 4. Strip No. 2 is nailed on strip No. 1 so that one fourth of the length of strip No. 1 extends beyond the end of No. 2. Strip No. 3 is nailed to strip No. 2, allowing one fourth of strip No. 2 to remain free. Then strip No. 4 is nailed to strip No. 3 with the same allowance and also to strip No. 1, thus completing a box, equal in length to one fourth the length of a single strip, at both ends of which are partially attached strips. The continuation may commence at either end, and the other end is filled with short pieces.

Holes are drilled through the sides of the pole at the end intended for the top, and the guys are attached in such a manner that the strain will fall equally upon all of the strips constituting the top of the pole. A tin can is placed over this end to keep out the rain. Two sets of guy wires, one from the top of the pole and the other from the middle, are all the support necessary.—GEORGE FREDERICK, Washington, D. C.

What Do You Need for Your Home Workshop?

HOME workers who must buy special parts, materials, or tools, will usually save themselves time and trouble by looking up the display and classified advertising in POPULAR SCIENCE MONTHLY. If the items desired are not listed in the advertisements, send a letter of inquiry to the Information Department, inclosing a stamped, self-addressed envelope. You can depend upon a prompt reply to your communication.

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THE HOME WORKSHOP

How to Make a Vacuum Tube Set for \$20

(Continued from page 75)

they can be obtained by making adjustments of the switches and the rheostat, the "tickler" coil, that is the rotor of the variocoupler, should be turned throughout its range until the best results are obtained.

In making your adjustments you will hear a howling or whistling noise that changes in pitch, going from a very high, shrill note to a very low note and then stopping and beginning again at a low pitch and going to a high pitch as you turn the rotor knob still farther. Always leave your adjustment at the point between the two low pitched notes. If there is no pause, or point, where the howling ceases when the low pitched tone is reached, cut down your tube current somewhat or make a slight adjustment of the switches until you do get a pause where there is no howling.

In making the switch adjustments, the tickler coil should be set at different angles until results are obtained. First try having the tickler coil concentric with the primary coil and move the switches through their whole range. Then, if you do not get results, vary the adjustment of the tickler coil by 10 or 20 degrees at a time until you do get results when making the other adjustments.

While very good results for a considerable time can be obtained by the use of a single dry battery for the filament current, it is cheaper in the long run to use two batteries connected in parallel or to use one of the special batteries consisting of several cells in one container, which are now being manufactured for use in connection with dry cell tube sets.

By following these directions you can obtain as good results with this set as from some commercial sets costing much more.

Homemade Electric Stove Keeps Soldering Iron Hot

THE soldering iron heater illustrated was built around the heating element from an old electric heater of the reflector type. These elements usually can be purchased new for \$2 or less.

The other materials used were: 1 piece of asbestos, $\frac{3}{8}$ by 4 by 7 in., 4 wooden feet, 2 binding posts, 1 length of asbestos covered



The soldering copper rests inside the porcelain spool of a heating element from an electric heater

heater cord, 1 attachment plug, 1 sheet metal hood, and the necessary screws and nuts.

The hood is galvanized sheet iron, $3\frac{1}{2}$ by 7 in., cut with a pair of tin snips. The point of the soldering iron goes inside the porcelain spool of the heating element. It is important to arrange the wire stand so that the bit will not touch the side of the spool, as otherwise the porcelain may become cracked.—J. M. Fox.



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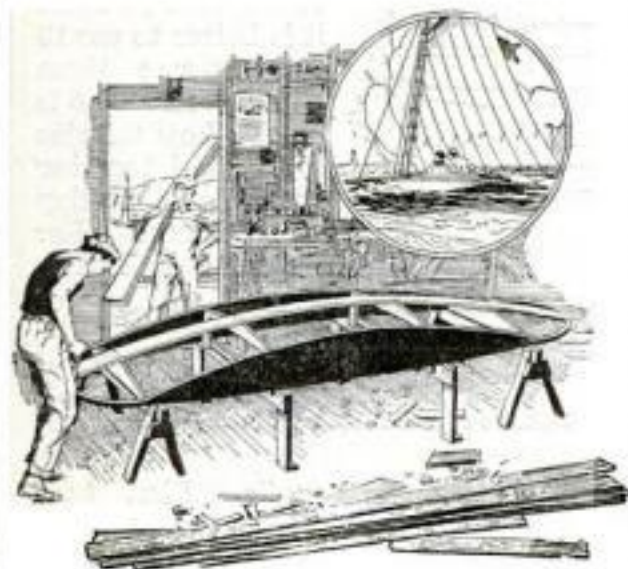
THE HOME WORKSHOP

Easily and Cheaply Built Sailing Lark Is Speedy Craft

By Stillman Taylor

THIS little craft is of the light draft, skimming-dish type, and is particularly well suited for a boy's use. Of simple and inexpensive construction, it is very fast under sail, especially in light winds, and yet its relatively wide beam makes it safe and stable. As there are no complicated curves, the boat can be built with a few common tools and does not take a great deal of time.

The molds (Fig. 1, page 106) are first made. They can be removed after the hull is ribbed and planked, but it is well to make them in the form of frames and nail



Although a fast and safe boat to sail, the lark has a hull that the amateur boat-builder can build without difficulty

the planking and decking directly to them, for that insures a very strong hull.

Four molds are required: Nos. 1 and 4 (Fig. 5) are alike and placed on the keel 2 ft. from each end; Nos. 2 and 3, also alike, are located 3 ft. 6 in. from the first two. This gives a 5-ft. cockpit. If a longer cockpit is wanted, simply fasten the top section of No. 3 mold temporarily in place with screws so that it can be removed and the cockpit extended an additional 18 in. aft.

When building the molds permanently as frames, saw them out of 2-in. spruce or hemlock. If they are used only to give form to the hull while building, make them out of any cheap 1-in. lumber at hand.

The sideboards (Fig. 2) are made of 3/4-in. cedar, spruce, or cypress. The keel (Fig. 3) should be 1 by 6 in. oak, or 2-in. spruce, cedar, or cypress.

The stems (Fig. 4) for bow and stern are
(Continued on page 106)



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THE HOME WORKSHOP

Easily Built Sailing Lark

(Continued from page 105)

exactly alike. While they may be steamed and bent to shape, the easiest and cheapest way to obtain them is to purchase a half set of rough, unfinished bent oak wagon rims 4 ft. in diameter, 2 in. wide, and 2 in. in depth. All fastenings should be made with $1\frac{1}{2}$ -in. screws, the heads being countersunk $\frac{1}{8}$ in.

The ribs can be fashioned from $\frac{3}{4}$ -in. oak strips, steamed and bent to shape, or made in two pieces. Equally strong ribs may be sawed out of $1\frac{1}{2}$ -in. spruce or hemlock, making them in two pieces, fastened by means of a batten strip on each side, and screwed solidly together. Not less than 10

ribs should be used; it is better to use 13 and space them closer. In Fig. 6 is shown how the ribs are spliced together where they overlap on the keel. For fastening oak ribs,

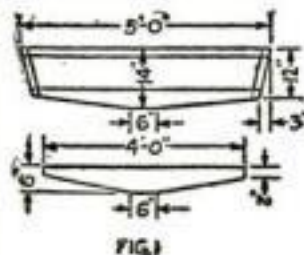


FIG. 1



FIG. 2

Details of the molds and sideboards

use galvanized boat nails. First bore through the rib and then from the outside drive nails long enough to clinch well on the inside of the ribs. For fastening the sawed out frames, use screws, countersinking the heads.

To plank the hull, turn the frame bottom up (Fig. 5) and fasten the planking at the stems with screws, and to the ribs and frames with nails. For the planking, cedar, spruce, or cypress boards, 6 in. wide and $\frac{5}{8}$ in. thick should be used. The planking is done by laying the first board next the keel and working out flush with the sideboards. To allow for caulking, a space of $\frac{1}{16}$ in. is usually left between all planks, but a better and tighter fit is secured by planing the edges of the joints to a slight bevel, the inner edges fitting together and the outer being open $\frac{1}{16}$ in., like a very narrow V. When the hull is planked, give the whole inside a coat of white lead paint.

The mast step or block is a piece of oak 1 by 6 by 9 in., with a square 3 by 3 in. hole cut in the center. This is screwed firmly to the keel 3 ft. from the bow.

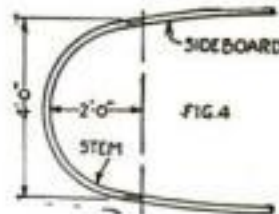


FIG. 4

The rudder post is located 3 ft. from the stern. Bore a 1-in. hole through the



FIG. 3

How the keel and stems are laid out

center of the keel; in this screw a piece of common iron pipe threaded at the end. This should be long enough to come up flush with the top of the deck. See Figs. 3 and 6.

The centerboard (Fig. 8) is formed by screwing two end posts 2 by 2 by 14 in. in each end of the 2-in. slot previously cut in the keel. To these the boards forming the casing, or trunk, are nailed after a few strands of candle wick or strips of woolen

(Continued on page 107)

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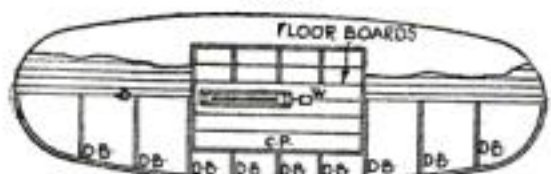
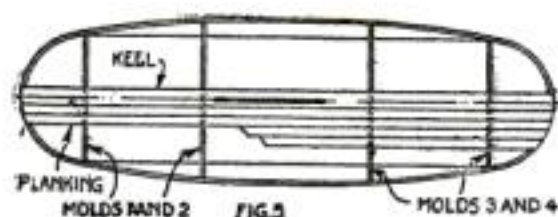
THE HOME WORKSHOP

Easily Built Sailing Lark

(Continued from page 106)

waste are placed along each side of the slot and brushed with a heavy coat of white lead paint. This will prevent any possible leakage. Paint the inside of the boards while putting the trunk together.

The centerboard is oak or cypress, the pieces joined with dowels. A single board would soon warp. Galvanized iron rods $\frac{1}{4}$



How the hull is framed and planked

in. in diameter may be used for the dowels, but if the boat is to be used on salt water use brass rods.

The board is hung in the case by a bolt running through the casing. Bore a 1-in. hole in the board about 3 in. from the bottom and 2 in. from the forward edge. Bore a $\frac{3}{4}$ -in. hole through the casing to register with the hole in the board and run a bolt through, using large washers. The iron centerboard rod (I, Fig. 10) is attached to the after top edge of the board.

For the top of the centerboard case, use a $\frac{1}{2}$ -in. board with a 1-in. hole bored to allow the rod to work freely up and down. Around the bottom of the trunk, on the keel, lay a few strands of wick or strips of waste, and tack on a 1-in. quarter round molding.

Oak strips 1 in. square can be used for the deck beams, but amply strong supports may be sawed out of any 1-in. lumber. All

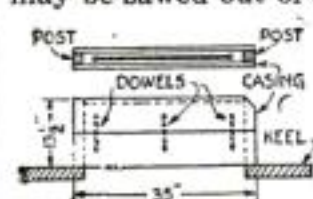
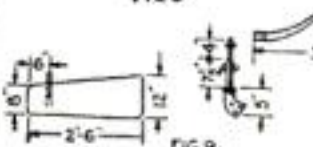


FIG. 8



Centerboard and rudder

beams are 3 in. wide and are screwed to the sides of the ribs flush with the top edges. If a curved or crowned deck is desired, simply saw the topsides of the deck beams to make them $1\frac{1}{2}$ in. higher in the center than at the ends. The third deck beam will form the plate for fastening the coaming at the forward end of the cockpit.

Decide upon the length of cockpit wanted and put in the stern deck beams in the same manner. The coaming plate is sawed out of 1-in. stuff, 4 in. wide, and run fore and aft in line with the keel (Fig. 7). To support the side decks, short deck beams made the same width as the longer ones, are run from ribs to the coaming plate. All beams and plates should be solidly screwed.

(Continued on page 108)

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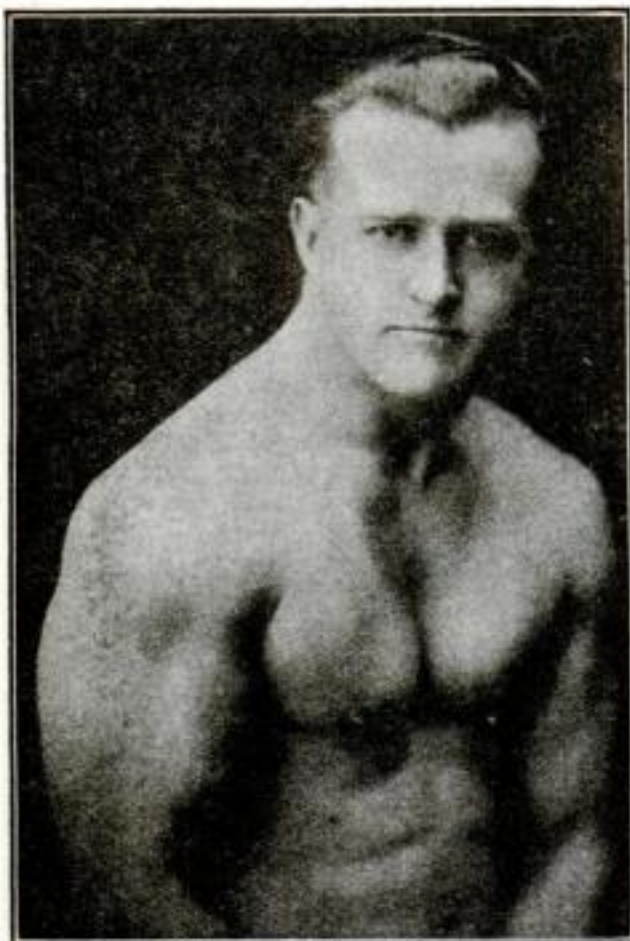
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THE HOME WORKSHOP

Easily Built Sailing Lark

(Continued from page 107)

The deck is covered with cedar or spruce boards 4 or 6 in. wide and $\frac{1}{2}$ in. thick. After fitting each board, it is a good plan to give the reverse side a coat of paint before nailing. When laying the side decks, put a few strips of waste along the top edge of the sideboards, coat with thick paint, and nail or screw solidly to the sideboards. Counter-sink all nail and screw heads and putty up all holes before laying the canvas.

The deck boards should be planed smooth. The canvas is put on dry or in wet paint, but to get a smooth and absolutely watertight deck, lay the canvas in glue by brushing black marine glue over the deck boards with an old stubby paintbrush, smearing it on as evenly as possible.

The canvas is put on in two sections, the seam running parallel with the keel. Let

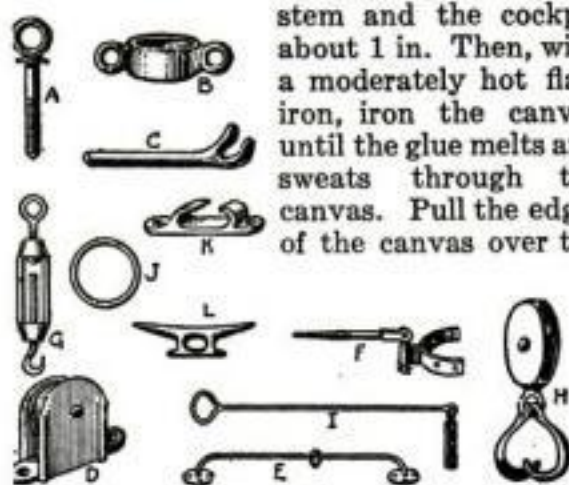


FIG. 10

Pulley blocks, traveler, and other
sailboat fittings

the canvas overlap the stem and the cockpit about 1 in. Then, with a moderately hot flat-iron, iron the canvas until the glue melts and sweats through the canvas. Pull the edges of the canvas over the

stem at bow and stern, gather neatly and tack the edges with copper tacks spaced close together. Lay the canvas on the other section in the same way, overlapping the canvas just laid by 1 in. and tack the seam with a double row of copper tacks. The rough edge of canvas on stem and sideboards is covered with a half round molding.

The cockpit coaming is made of $\frac{1}{8}$ -in. boards 6 in. wide, screwed to the plates so as to project above deck about 2 in. To make a neat finish, run a small quarter round molding around the canvas deck and tack it to the coaming.

The cockpit flooring, of 1-in. stuff, is now screwed to the ribs. Just aft of the center-board cut out a square hole in the floor between the ribs, so that water may easily be bailed or pumped out.

The rudder (Fig. 9) is of $\frac{3}{4}$ -in. oak. For the rudder post an iron rod about $\frac{1}{2}$ in. in diameter is forged as shown. Any blacksmith will do this, and make the tiller to fit, for a small sum. The post is attached to the rudder blade with screws or rivets.

The mast, boom, and gaff may be planed out of spruce or hemlock. It is an easy matter to make the spars round and tapering by first planing to the desired taper in the square. Then take off the four corners and reduce in turn to make the stick eight sided. The spar may then be scraped round and smooth with a common steel cabinet scraper.

The mast is supported with a single wire rope stay running from an eye in the mast band to a turnbuckle hooked into an eyebolt screwed into the oak stem. The foot of

(Continued on page 109)

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THE HOME WORKSHOP

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(Continued from page 108)

the mast is cut square to fit the mast block screwed to the keel, and to prevent splitting the thin deck, a block of 1-in. oak, with a hole a trifle larger than the diameter of the mast at the deck, should be screwed firmly to the deck. The mast should not be less than $3\frac{1}{2}$ in. in diameter from heel to deck and should taper uniformly to about $2\frac{1}{4}$ in. at the mast head. From deck to top it is 15 ft.

The boom is $2\frac{1}{2}$ in. in the center, tapering to about 2 in. at the ends; the gaff 2 in. in the center, tapering to $1\frac{1}{2}$ in. Both should be at least 6 in. longer than the width of sail to allow for the stretching of the canvas. The best way of attaching the boom to the mast is to use a gooseneck, *F*, Fig. 10, with a plate to screw to the mast, and a long screw to screw into the end of the boom. Jaws, *C*, sawed out of 1-in. oak and bolted or screwed to the gaff attach this spar to the mast.

How to Stitch the Sail

For the sail $5\frac{1}{2}$ - or 6-oz. cotton drill is heavy enough. It can be stitched on the sewing machine. The narrow, bighted effect can be obtained by folding over a lap of the goods and double stitching the fold. The bights should run parallel with the after edge or leech, as shown in the sail plan. Sew all the breadths together, then stitch in the laps. Run a 1-in. hem along the leech and a $1\frac{1}{2}$ -in. hem along the hoist, boom, and gaff. At each corner of the sail stitch on a circular reinforcing patch, as shown.

When cutting the sail to shape, be sure to cut the foot sail at end of boom at least 12 in. higher than the sail at the mast. This is necessary to give clearance space when the boom swings over.

About 18 in. from and parallel with the boom, sew in a row of reef points. Cotton rope $\frac{1}{8}$ in. in diameter is about right for this, the ends being whipped to prevent unraveling.

Attaching Sail to the Mast

The sail is attached to the mast with oak or metal mast hoops, *J*, Fig. 10, and the boom and gaff are attached by lacing with $1\frac{1}{8}$ -in. cotton cord. Grommet holes are worked in for each mast hoop and in the bights or laps of the sail along the boom and gaff sides. To make the grommets, purchase 3 doz. galvanized iron or brass grommet rings, about $\frac{1}{2}$ in. in diameter. Punch a small hole in the spot where the grommet is wanted, place a ring on each side of the hole, and sew the rings to the sail with waxed sail twine, using an overcasting stitch. Work a row of grommets along the gaff and boom in the same way.

For the mast a band with two eyes is needed (*B*, Fig. 10). Slip this over the top of mast and slide it down until it wedges. To the forward eye, splice or seize the end of the $3/16$ -in. wire rope stay; in the after eye, hook the sister hook pulley block for the peak halyards. About 1 ft. below, screw an eyebolt in the after side of the mast directly in line with the eye in mast band. Hook another pulley block in this eyebolt for the throat halyards. The best blocks to use are galvanized iron to take a $1/4$ -in. manila rope.

On the deck, at each side of the mast,

(Continued on page 110)

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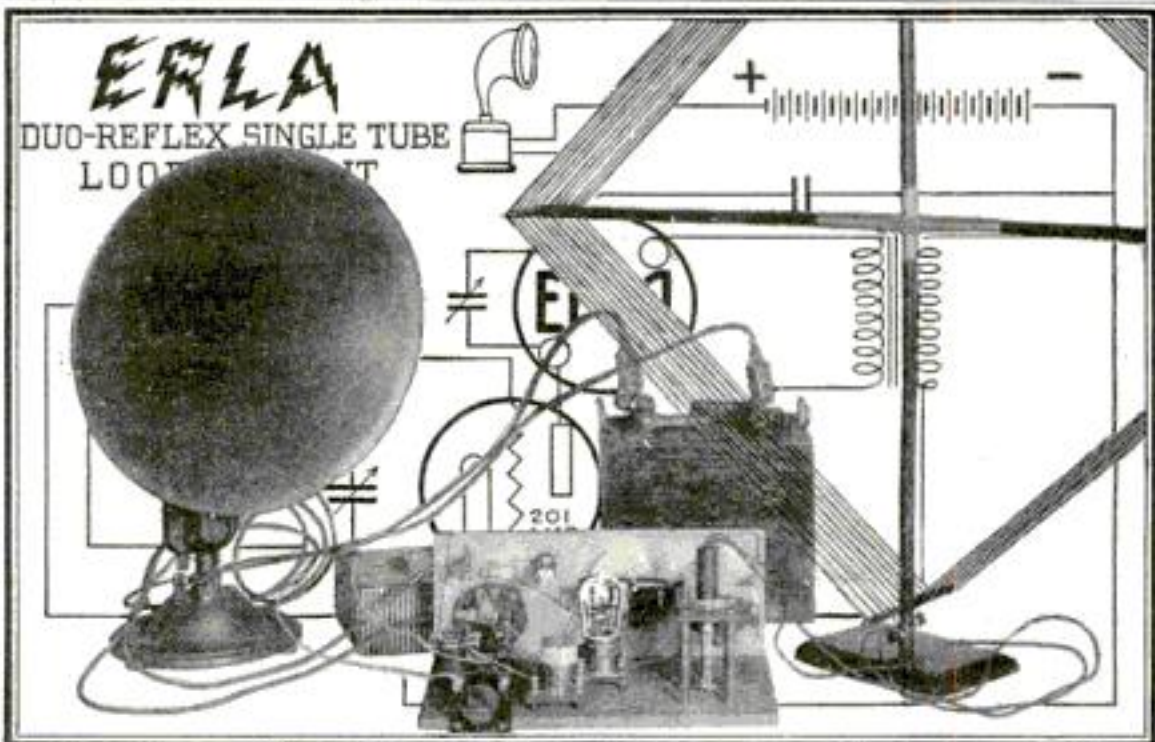
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THE HOME WORKSHOP

Easily Built Sailing Lark

(Continued from page 109)

screw a galvanized deck pulley (O, Fig. 10). Place these 12 in. from the mast and in direct line with the center of it, and lead the throat halyards through one block and the peak halyards through the other. This arrangement serves to support the mast and answers the same purpose as a wire side stays or shrouds. That the halyards may be within easy reach of the steersman, it is a good plan to have them long enough to lead to the cockpit and fasten to cleats screwed on each side of the after end of the center-board trunk.

In the center of the oak stem at the bow screw in a heavy eyebolt (A, Fig. 10), and in this insert a turnbuckle, G. Seize the end of the wire rope stay to the eye of the turnbuckle, and set the stay up taut. Near the stay screw a 3-in. bow chock, K, to the stem, so that the mooring line will lead fair. A cleat, L, is always in the way on the forward deck, and it is best to make the end of the mooring rope fast to the mast.

Rigging the Main Sheet

For the main sheet, three single pulley blocks for 1/4-in. rope may be used. These should be fitted with sister or match hooks, H, like the others. Two are made fast to the boom, and the third seized to the ring in the traveler, the latter being screwed to the after deck. By using a traveler, E, the sail will shift without attention, thus saving the bother of shifting from one cleat to another when going about.

The boat should be smoothed with sandpaper and given three coats of white paint. All screws and nail holes should be puttied after the priming coat. The mast and spars should be protected with two or three coats of outside spar varnish. The coaming may be varnished instead of painted, if preferred.

For mooring the boat, a 20-lb. anchor and a 3/4-in. mooring cable of manila rope will be needed.

Home Workshop Features that Will Save You Money

ARE you going to build a garage this year? If so, you will be interested in the plans for an attractive pergola garage in next month's Home Workshop.

Mr. Joe V. Romig will tell how to build a small motor unit that performs many tiresome household tasks.

The "Secrets of Making Realistic 'Antique' Furniture," omitted this month because of space restrictions, will appear in May.

What you can do in the way of concrete work about your house and garden will be the subject of another feature.

There will also be the usual helpful and constructive radio articles.

Make a Gas Range out of Your Old Stove in Five Minutes



Your old coal or wood stove can be made into a practical gas range in a jiffy. Absolutely no changes to make. Just set a marvelous new kind of burner in the fire box, attach to a tank of coal oil by means of a copper tube, turn a valve, strike a match. Instantly you have a heating flame as steady and easy to control as city gas, at one-third the cost.

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THE HOME WORKSHOP

Grandfather's Clock Cases

(Continued from page 76)

cost of blueprinting and handling. Those who wish to make the clock should obtain the blueprint, because it will save much time in getting the stock. It should be noted that the case has been designed to take the largest and most complicated chiming works. For smaller movements the dimensions can be scaled down as required.

The other designs on page 76 represent varying degrees of simplicity or elaboration. The easiest and cheapest to make is the design marked No. 1, sometimes called a Mission style hall clock. It is 17½ by 13½ in. and 6 ft. 2 in. high. Number 2 is a mahogany clock 7 ft. 7 in. high, 26 in. wide and 18 in. deep. Number 3 is 7 ft. 6 in. high, 25 in. wide and 14½ in. deep, and No. 4 is 7 ft. 1 in., 22 in., and 13 in.

The lower illustration on page 76 is a magnificent inlaid clock, now in the Metropolitan Museum, New York City, that will



A grandfather's clock copied from one made shortly after the Revolution, with details of the bonnet construction

tax the utmost ability of the home craftsman to copy successfully.

The case above is another Colonial clock, 6 ft. 8 in. high, 18½ in. wide, and 10 in. deep. The easiest way to start it is to cut out the back to shape and then add the ends and front. The cut-off corners may be left plain, or fluted or reeded.

The arch at the top of the bonnet is cut on a radius of 7 in. and the radius on the top of the door is 5¼ in. The top of the bonnet is covered with thin strips of wood glued to canvas. As in the case of the first clock described, a mahogany mat about 5/16 in. thick is glued to the inside edge of the arch. The moldings can be cut with gouges and cleaned up with sandpaper. In old clocks the ornamental urns are ordinarily of brass, but wood may be used. The circle that decorates the base is inlay, and, if desired, the space within it can be veneered with a different wood from the remainder of the case.

Movements and dials for clocks can be purchased ready to be inserted in the case. These range from simple movements that strike the half hours, at about \$5, up to magnificent two-chime tubular movements.

A very popular movement is known as the "Black Forest." It is run with either heavy brass chains and weights or with enameled iron weights, and usually is accompanied by a white enameled wooden dial, although other dials can be used.

More expensive movements have as many as nine-tube chimes.

(Continued on page 112)

CLARENCE A. O'BRIEN

PATENT ATTORNEY

REGISTERED IN UNITED STATES PATENT OFFICE

MEMBER OF THE BAR OF

SUPREME COURT OF UNITED STATES COURT OF APPEALS DISTRICT OF COLUMBIA

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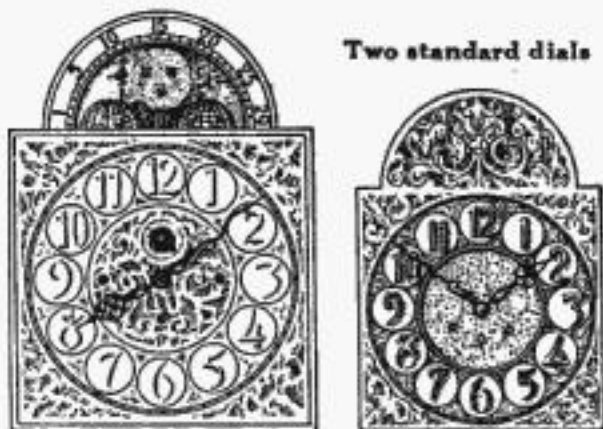
THE HOME WORKSHOP

Grandfather's Clock Cases

(Continued from page 111)

Dials of many varieties also can be obtained, some of the finer ones being of brass with gold plated corners, enameled etched numerals, lunar arch and movable moon. These can be obtained through jewelers and watchmakers, manual training supply houses and clockmakers. It is advisable to obtain the dial, if not the works, before laying out the case so that the dial will be sure to fit.

If a fine case is made for the clock, it is well worth the additional price to put in a



Two standard dials



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Be Thou our guide, | No foot shall slide.



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The Westminster and Whittington chimes

chime movement. The chime that is commonly used is the Westminster, which is supposed to have been based upon an idea taken by a Doctor Randall from a movement in the fifth bar of Handel's "I Know that My Redeemer Liveth." The Whittington chimes are famous through their connection with the legend of Dick Whittington.

How to Make a Flexible Mirror with Celluloid and Tinfoil

TO MAKE an unbreakable flexible mirror requires only a sheet of perfectly clear, clean celluloid, a sheet of absolutely smooth and unbroken tinfoil, and a little mercury.

First, lay the tinfoil smoothly on a hard, flat surface, such as a sheet of glass, and pour a little mercury on it. Then dab the mercury on the foil with a soft lintless rag or a piece of chamois. When the mercury is spread as evenly as possible, hold the celluloid in a curved position and put down one edge on the foil, press it with a soft rag, pushing out the bubbles of air, and let the sheet down a little at a time, to force out the bubbles and excess mercury. Next lay another sheet of glass on the celluloid, place a weight on top and leave it thus for several days.

Apply a coat of paint or varnish to protect the back and trim the edges.

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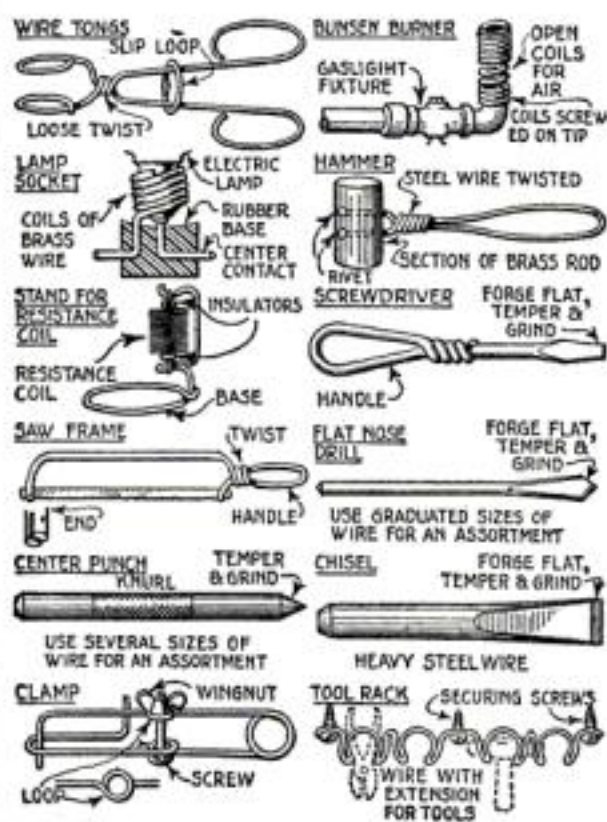
Wire and Ingenuity Provide
Many Tools and Fixtures

By G. A. Luers

THE usefulness of wire is practically limitless. Tools, fixtures, mechanisms, and devices for innumerable purposes can be made of wire or formed with wire as an integral part. It would be impractical to attempt to enumerate even a small percentage of wire devices. These twelve useful ideas, however, will suggest others that can be used to equal advantage in the home workshop.

WIRE TONGS—Bent wire forms two scissor-like handles, with a hinge and a sliding catch. These are made of $\frac{1}{8}$ -in. steel wire or equally as stiff iron wire, and are useful for soldering, heating, and on acid work.

BUNSEN BURNER—This is for a gas fixture. The wire is coiled to fit the thread and opened at the center to admit air.



These 12 suggestions indicate the many uses for wire in the home workshop

Wind the coil close and open gradually until the gas burns with a light blue flame, intensely hot.

LAMP SOCKET—Brass wire is coiled to meet the threads of a candelabra light and attached to a piece of hard rubber. The center contact is brass wire.

HAMMER—A short piece of round or square brass is fitted with a twisted wire handle by drilling holes and forcing the wire ends into place. The ends are then riveted.

STAND FOR RESISTANCE COIL—By bending wire to the shape indicated, a support is made to hold a resistance coil. Insulators are placed at the points of attachment.

SCREWDRIVERS—Bent wire forms the handle. The working end is flattened, hardened, and ground. Several graduated sizes are serviceable.

SAW FRAME—Heavy steel wire is bent as shown and hacksaw slots cut for the ends of blades. Frames for metal saws or for fine coping saws may be made to suit any size or style of blade.

FLAT NOSE DRILLS—Use graduated sizes of steel wire, forge the ends out, and temper by heating on a Bunsen burner and

(Continued on page 114)

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THE HOME WORKSHOP

Wire Provides Many Tools

(Continued from page 113)

thrusting into a potato. Grind the points to a bevel, as on drills.

PRICK PUNCHES—Use same size of wire as for larger drills; temper and grind to conical points. If a lathe is available, knurl the stems.

CHISELS—Use heavy steel wire, forge ends flat, temper as suggested for drills, and bevel the point by grinding.

CLAMP—Bend wire as shown and use a small screw and wingnut to obtain pressure. This clamp is useful for holding parts while soldering, brazing, drilling, etc.

TOOL RACK—This rack is made from a length of wire with bends to accommodate the various tools and equipment.

How to Make Attractive Vases from Old Glass Bottles

MOST attics and cellars contain a lot of old pickle and fruit bottles, some of which may be put to good use in the following way:

The selected bottles should be washed out and thoroughly dried. A sheet of iron is then placed over the gas burner and the gas is lighted. One of the bottles is placed on the plate and allowed to become hot enough to melt sealing-wax when it touches it. Sticks of sealing-wax of various colors, which may be purchased at any stationery store, are melted by contact with the surface of the bottle.

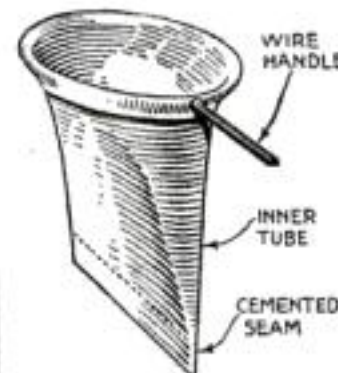


Colored sealing wax is blended over the heated glass

If a careful choice of colors is made, some very beautiful effects can be obtained by allowing them to blend into one another.—**J. B. MORAN, New York.**

Inner Tube Serves as Emergency Dipper for Auto Tourist

WHEN it becomes necessary to fill a radiator while on the road, where there is water but no utensil to carry it, look for an old inner tube. If you have one, a section cut from it will hold water and the valve stem will serve as a carrying handle.



For filling the radiator

The better plan is to have handy in the car a water carrier made as shown, with a handle and rim of heavy wire. Cut an old tube square across, punch a hole in it two or three inches from one end and pass the handle end of the wire through it. Then pass the tube through the ring part, curl the short upper part of the tube down over the outside of the ring and cement it. Cut the tube off at any convenient length and cement the lower end.—**LOUIS SCHNEIDER, Clinton, Mo.**

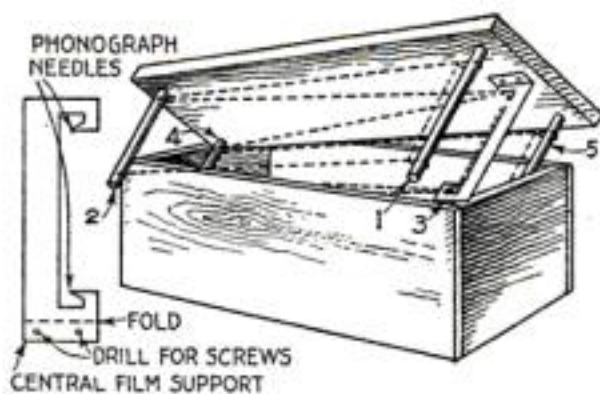
THE HOME WORKSHOP

Cheaply Made Developing Tank Aids Amateur Photographer

By H. C. McKay

IN DEVELOPING films by the tank method, which has much to recommend it, a homemade darkroom tank will often serve the purposes of an expensive commercial daylight tank. In case the amateur wishes to watch the process of development, as in a high temperature when the various developers fail to work according to the usual standards, a darkroom tank has advantages of its own. Such a tank, which I made at a trifling cost for use in Florida, has given perfect satisfaction.

The dimensions of the tank will vary with the size of the film. Cypress $\frac{1}{2}$ in. thick should be used, and the inside width of the tank should be about 3 in., the depth 1 in. more than the width of the film, and



The completed tank and detail of the central film support

the length $\frac{1}{4}$ in. longer than one quarter the length of the film. Screw the pieces together and paint the tank with several coats of paraffin inside and out, or, if possible, boil the sides and bottom in paraffin before assembling.

The combined cover and hanger is made of $\frac{3}{4}$ -in. hard wood in which are inserted four nickel-plated bolts to serve as supports. These bolts are so placed that they will be $\frac{1}{2}$ in. from the two sides at each corner. If the bolts are threaded for their entire length, it is well to wrap them with a layer of cheesecloth to prevent the threads from scratching the back of the film.

From sheet metal, make a central film support, as shown. The points are phonograph needles soldered to the metal. For the best results, this piece should be nickel-plated, which a jeweler will do for a few cents. The part is attached to the cover between the bolts at one end.

The tank is filled with developer to within $\frac{1}{4}$ in. of the top. The end of the film is bent around post No. 1 and fastened with a brass pin. Care should be taken that the film side is out. It is then passed over post No. 2, behind the points of piece No. 3, which should pierce the film; then over post No. 4 and back to post No. 5, where the end is pinned.

The use of piece No. 3, instead of another bolt, is what makes it possible to thread the film in this way, so that there is no obstruction against the face of the film to retard development. The film is then lowered into the tank and left the requisite time.

ANY one who has tried to paint new galvanized iron pipe knows how difficult it is to make the paint stick. This can be remedied by cleaning the pipe, preparatory to painting, with a solution of water and ammonia in equal parts.

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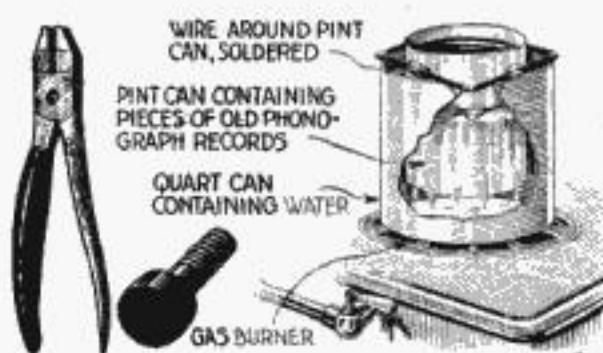
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THE HOME WORKSHOP

How to Insulate Radio Parts and Tool Handles

AS AN insulation for electric switches, sockets, knobs, switch blade handles and screwdriver and plier handles, the home worker can use bits of broken phonograph records melted in a double boiler similar to



Broken phonograph records are melted in a double boiler made of cans

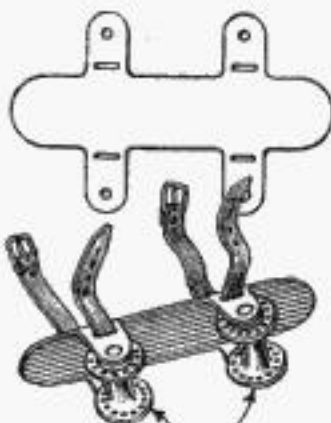
a gluepot. The material is a good insulator and adheres perfectly to clean metal.

It is not possible to obtain a thick coating by dipping an object once, but repeated dippings will result in as thick a layer as desired. The container shown is simply a pint can with a wire rim soldered to it, so that it can be suspended in a quart can filled with water kept hot over a stove. This arrangement prevents overheating the composition.—F. L. J.

Old Bicycle Hubs Serve as Roller Skate Wheels

ANY boy can readily make for himself a pair of roller-skates by using old bicycle hubs and heavy galvanized sheet iron as a foot base.

Cut the sheet iron the size and shape of the foot, leaving ears with slots for straps. Bend the ears over as shown, to extend above the foot-base 1 in. Small, heavy steel bassinet wheels, often sold for 5 cents each, can also be used.—C. A. BLACK, JR., Hightstown, N. J.

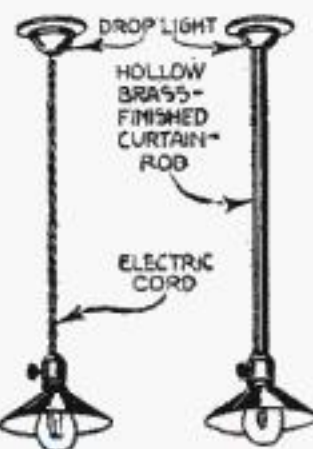


It costs little to improvise these skates

Improving Droplights

TO IMPROVE the appearance of electric droplights, purchase hollow brass curtain-rods large enough for the lamp cord to be threaded through them. Each rod, which consists of two parts sliding one on the other, will serve for two droplights.

If the cord is too long after it has been run through the curtain-rod, as shown, cut it off, and if the rod is too long for the cord, cut the rod.—A. LEWIS, Regina, Sask., Can.



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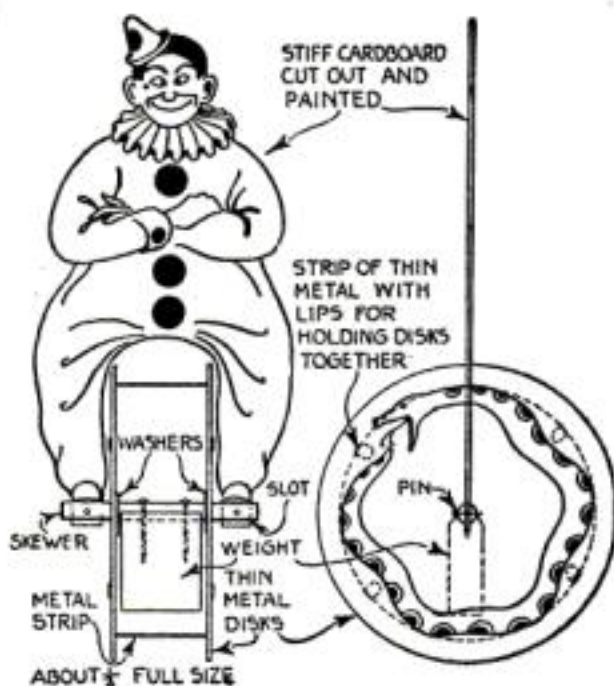
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THE HOME WORKSHOP

Trick Clown Rides a Wheel without Falling Off

A NOVELTY that will amuse the kiddies and often puzzle grown-ups can be made as shown below.

The clown, which is cut from stiff cardboard and painted, is fastened to a short



Front and side views of amusing roller toy

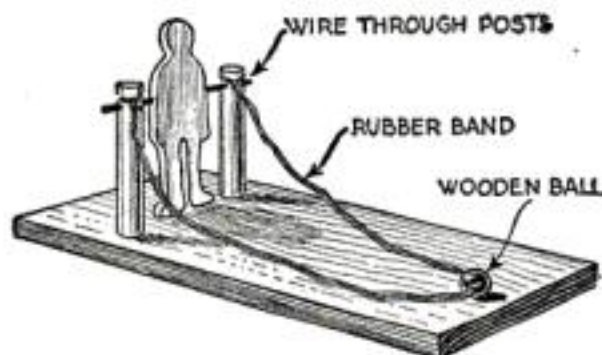
length of a butcher's skewer or other round stick. The stick forms an axle for the wheel, but has a lead weight attached to it so that, no matter how the wheel turns, the clown remains upright. The axle must turn freely so that the figure will not tend to go around with the wheel.

The details are clearly indicated in the illustration.—D. W. CLARK, Buffalo, N. Y.

Sling-Shot Target Toy Provides Endless Fun for the Kiddies

THE illustration shows a clever toy that may be made in a few minutes by the handy man. First, a little wooden man is cut out, and a piece of heavy wire is passed through him as shown. Two posts are then mounted on a board, with two holes drilled through them at the top.

The wire that was placed through the little wooden man is placed in these holes



The ball is shot at the target to make the figure spin around

and the posts are then inserted in the holes in the base of the device and glued there.

Attached to the two posts is a long rubber band upon which is mounted a little wooden ball with a hole through it.

When the ball is pulled back and allowed to fly forward, hitting the little man in the right spot, it will make him spin around rapidly.—G. BENDER, Jersey City, N. J.

How about the corncob?

The old family meerschaum stirs no thrills in this smoker

"Dear Sirs and so forth," begins a letter we recently received from H. T. Spenser, Madison, Wisconsin, "I am cupping my hands in the shape of a megaphone and shouting a loud echo of approval to your correspondent who smokes a meerschaum pipe fifty years old.

"But I don't want him or any other smoker to get away with the idea that a meerschaum is the only pipe where Edgeworth is concerned.

"For, you see, I am a corncob smoker. What's more, I am a corncob - Edgeworth smoker!

"The corncob-Edgeworth combination is hard to beat. I have tried almost every combination of pipe and tobacco there is and have yet to find one that can approach it for year-in-and-year-out pipe smoking.

"So if you're starting a Corn-cob - Edgeworth Clan, don't forget to put me down as a charter member."

We are continually being surprised by smokers who discover things about Edgeworth that we don't know ourselves. For instance, we never suspected that Edgeworth smokes any better in a corncob than it does in a briar. Frankly, we don't believe that it does. At any rate, we have any number of friends who claim that Edgeworth is the only tobacco to use in briars, in calabashes, in meerschaums, or in clays.

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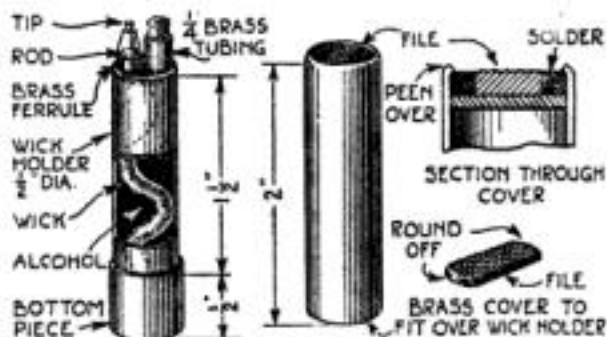
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THE HOME WORKSHOP

How to Make a Durable Pocket Cigar Lighter

THIS handy pocket cigar lighter can be made from a few small pieces of brass tubing and a friction gas-stove lighter. The tip, the file, and a small piece of wire rod are the parts obtained from the stove lighter. The tip is removable and can be replaced when worn down.

The body and cap are two pieces of telescoping brass tubing, the inside tube about 1/2 in. outside diameter, although a little larger or smaller size could be used. The lighter when closed is about 2 1/2 in. long. The top of the cap and the top of the bottom pieces of the wick container are 1/32-in. sheet brass carefully filed to size and



Striking the gas-lighter tip with the file makes a spark that ignites the wicking

soldered securely in place. The wick collar, made of 1/4-in. brass tubing, is soldered—together with the small ferrule that supports the wire—to the top.

The file is cut down on an emery wheel and the ends are rounded and beveled so as to fit within the tubing of the cap. After the file is in place, the tubing is clinched over the ends of the file and the spaces on both sides are filled with solder. Wicking thoroughly saturated with alcohol is inserted through the 1/4-in. collar and pushed in until it practically fills the container. The lighter can be highly polished and given a thin coat of lacquer or shellac.

The tip is struck with the file and the resulting sparks ignite the wick. Replacing the cap extinguishes the flame.—H. CLAUSEN, Glen Ellyn, Ill.

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A piece of rod is similarly cut up to represent ounces. The shape of each piece indicates its weight.

The scale is a balanced ruler or a bar with two small lids attached to its ends with string, to serve as pans.—F. C. D.



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THE HOME WORKSHOP

How to Set a Jewel in Your Fountain Pen Clip

A JEWELLED pen or pencil clip is a novelty that can be duplicated with little difficulty or expense. The jewel is set in the ball of the clip and the method is such that any home worker without previous experience can do the work.



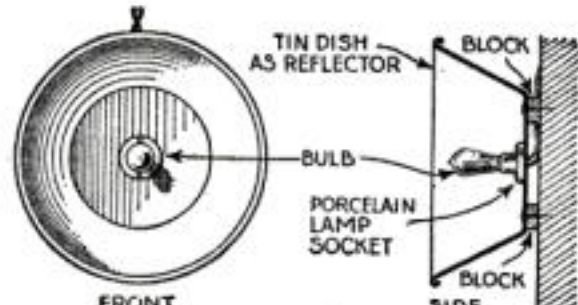
Plaster of Paris holds the gem in place

A hole is bored part or all of the way through the clip and into it is dropped a mixture of plaster of Paris and water. The jewel is then placed on the plaster and the clip is put aside for a day to dry. If the hole is bored all the way through, it should taper toward the front a little so that the gem may be put in from the rear and driven forward until it is wedged firmly in place. If it is set by this method, it cannot fall out unless it is pressed from the front.—J. L. DOUGHERTY, Toledo, Ohio.

Reflector for Garage Lamp

AN INEXPENSIVE but effective method of illuminating the private garage for making night repairs is shown in the accompanying drawing.

In the forward end of the garage is placed a fixed lamp socket surrounded by a cheap



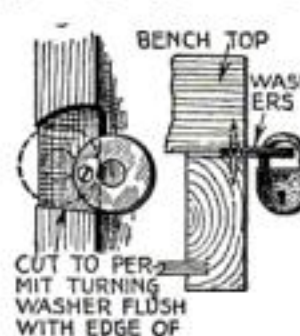
A tin dish makes a cheap reflector for night repairs in the garage

bright tin dishpan. With this improvised reflector, a 32-candlepower electric-light bulb provides a good light.—G. A.

A Bench Drawer Hasp that Isn't in the Way

IT IS not usually desirable to use a hasp on the face of a bench drawer, because it protrudes and is in the way. Sooner or later it is bound to catch and tear the overalls or clothing.

A hasp that does not project can, however, be provided very easily by pivoting a large washer on the top edge of the drawer and another washer in line with it on the under side of the bench top. If a recess is cut for these washers, as shown, they may be pushed back out of the way when the drawer is not locked. Since the screws are concealed when the drawer is locked, the washers cannot be removed by any one trying to force the drawer unless a piece is broken out of the drawer front.—N. H.



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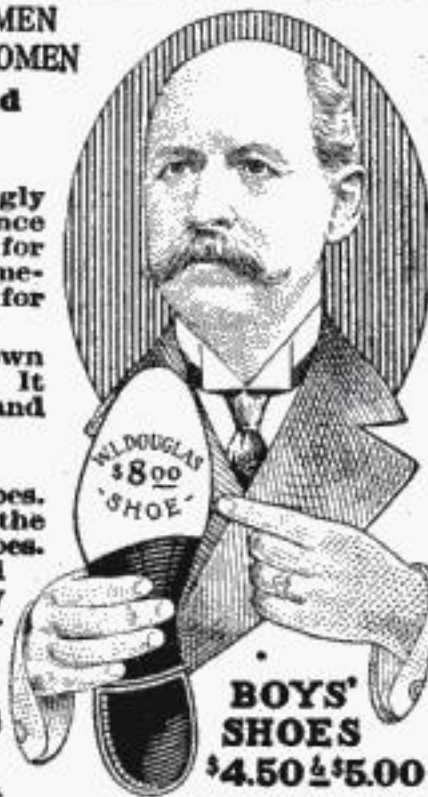
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How Our Earth Was Formed

(Continued from page 28)

future from the stars? Is our earth destined to perish in a stellar collision, to die as it was born in the flaming cataclysm of two stars that chance to come too close together?

Perhaps it is, but such a flaming doom is far from imminent. The nearest star is some 26 trillions of miles away. For the sun to go so far will take over 60,000 years. Even this is far too short, for we are not moving in this direction and even the more distant stars toward which we are moving are moving also. Long before we get there, they will be gone. Other stars, of course, will have moved in to take their places. Perhaps one of these is destined to hit us; but space is wide and the chance is small.

I have compared the stars in space to gnats flying about in a room. If the gnats are as far away from each other, on the average, as the stars are, there will be about seven gnats in a room two miles square. You can imagine that there will be small chance for two gnats accidentally to bump into each other. Probably life's record in the future will be even longer than its record in the past.

And what is this record of life's past?

That is the story we are telling in this serial; the story last month, of how life began; the story, next month, of how man arose out of the lower creatures.

When Life Began

When the earth was fully formed and had grown cool enough for life, when the ocean was ready, when there were rocks and a seashore and an atmosphere clear enough for the sun to shine through, then life began. We find its traces in the oldest rocks, the ones at the very bottom of the pile of geologic strata. A little higher in the pile we find more complicated creatures—worms and shellfish and the curious bug-like trilobites, who dominated the seas for perhaps 200,000,000 years.

But was life to go on forever in the seas where it had begun? Was the land never to be conquered by higher forms of life? Was man himself never to emerge as the masterpiece of evolution among innumerable land dwelling animals?

These questions would not have been answered as they have been but for the blind efforts of a curious race of fishes, which, in the next article, we see striving to perfect their bodies so that they could conquer a new realm for life. We see how they struggled generation after generation, age after age, to learn to breathe air instead of water; and how Nature finally conspired with them to perfect one of the most revolutionary inventions of all time—the invention of the lungs.

Q Next month—Man's Animal Ancestors; His Family Tree—another thrilling story in this amazing series!

Simply and understandably, Doctor Free will tell the most absorbing mystery and most fascinating romance of science—life and its conquest of the world. His story is big, vital and interesting.

Ask your newsdealer today to save your copy of **POPULAR SCIENCE MONTHLY** for May.

Q The reader seeking further information on the wonderfully fascinating subjects outlined in the foregoing article will find the two following books of particular interest:

"The Evolution of the Earth and Its Inhabitants," by Richard S. Lull (Yale University Press), and "A Textbook of Historical Geology," by Charles Schuchert (John Wiley and Sons, N. Y.).



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Technical drawing of a towel rack showing front and side views with dimensions.

Front View Dimensions:

- Top bar width: $23\frac{1}{2}''$
- Top bar height: $\frac{3}{8}''$ MORTISE
- Overall height: $30''$
- Bottom bar width: $20''$
- Bottom bar height: $2\frac{3}{4}''$
- Label: TOWEL ROD

Side View Dimensions:

- Top bar width: $9''$
- Top bar height: $8\frac{1}{2}''$
- Second bar height: $8''$
- Third bar height: $6''$
- Fourth bar height: $6''$
- Bottom bar height: $10''$
- Bottom bar width: $3\frac{1}{2}''$
- Bottom bar height: $3''$
- Bottom bar width: $2''$
- Bottom bar height: $5\frac{1}{2}''$
- Bottom bar width: $1\frac{1}{2}''$
- Bottom bar height: $4''$
- Label: SIDE PANEL



A detailed black and white illustration of various brass instruments. At the top is a long, slender instrument, possibly a flugelhorn or a long trumpet. Below it, a trumpet is shown in profile. To the left of the trumpet is a trombone. In the center, a tuba or euphonium is depicted. To the right of the tuba is a saxophone. The instruments are arranged within a decorative, ornate frame that has a scalloped top and bottom edge. The background within the frame is dark and textured.



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"To use a cataract you build a power plant on the shore.

"To use TIME you must build a power plant in the MIND."

So writes the editor of the *New York American*. His three sentences contain a great truth.

THINK right now of where you stand and where you *might* stand in further power and higher position. Then let us tell you what we are doing to help thousands of other young men to rise to occupations that bring more responsible work, better pay, more happiness, comforts and privileges—all through just the use of spare hours guided by our distinctive instruction-by-mail service.

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THE HOME WORKSHOP

He Made Money Repairing an Old Cottage in Spare Time

WHEN other men are in the "gym" or playing tennis or golf, I am in my home workshop. I take my exercise in that way, and my shop, besides "keeping me fit" and giving pleasure, brings in considerable money throughout the year.

On one occasion when I ran out of other work, I bought a small cottage that badly needed repairs. The house had a sitting room, dining room, two bedrooms, kitchen, and bath, and while it was not particularly attractive, I had the idea that I could fix it up and sell it when completed at a price to repay me well for my work.

The changes upon which I decided were these: To put in a furnace, tear out a partition in the kitchen and make a breakfast nook, cut in extra openings for double windows, repaper all the rooms, paint the kitchen and dining room with white enamel, build in a china cupboard opening in both kitchen and dining room, overhaul the plumbing, lay new floors over the entire



This house, remodeled by the owner, sold for \$1500 more than it cost

house, convert a rear lean-to into a sewing room, and arrange the basement for a furnace, coalbin and vegetable storeroom.

I had to rebuild the foundation of the chimney to make possible the installation of a furnace in the cellar. I had a boy help me with this work, and then put in a pit and furnace foundation and cemented the floor. Later I partitioned off a coalbin and vegetable room. The furnace itself was set in place by the dealers.

Next, I had the plumbing repaired and a new kitchen sink and hot water tank installed. Cutting in the extra windows immediately made the interior more attractive, and by converting the pantry into a breakfast corner, the kitchen was enlarged and made more serviceable.

I then wired the house for electricity, finished all the carpentry work, except laying the new floors, and painted or varnished the woodwork. When the papering was finished, I laid a thin maple flooring, sanded it with a floor machine, and gave it three coats of varnish. The light fixtures, pretty but not very expensive, were put in last.

The entire cost of repairs, including good pay for my own time, was less than \$1000. We liked the house so well that we lived in it ourselves for two years, and then sold it for \$1500 above the purchase price.—FRANK W. SHULTIS, Lansing, Mich.

Reconditioning Cement that Has Been Long in Storage

CEMENT that has been stored for a long time takes what is known as a "warehouse set." It can be reconditioned by rolling or dropping the sacks on the floor, provided it has not been spoiled by dampness.

Lumps that cannot be crushed by hand should be discarded.—C. L.



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THE HOME WORKSHOP

Six of Your Most Pressing Radio Questions Answered

By the Information Editor

"HOW can I improve my radio set?"

This question in some form is the subject of 700 of every 1000 letters I receive as Information Editor of POPULAR SCIENCE MONTHLY. And this is the question eternally uppermost in the minds of thousands of radio fans.

Curiously enough, almost equally numerous are the two main trends taken by questions of this kind. "How can I increase the distance range of my set?" is the most frequent plea from the radio fan, and "How can I increase the volume of sound from my set?" closely follows it.

There are many answers, of course, to the first question. In general, it is safe to say that by a close study of the design of a radio receiving set, it is possible to receive over distances of from 500 to 1000 miles, merely by using a detector and one stage of amplification. As a matter of fact, 1000 miles is often covered by the use of a single detector tube.

In the construction of such a set, careful attention must be given to the tuning elements, since at these great distances, selectivity is of primary importance. A set that will not tune very closely cannot be used to span great distances.

This selectivity can be obtained by the use of a variocoupler-variometer hook-up or a variocoupler with an extra rotor, the winding of which acts as a tickler coil. The primary of the variocoupler should have just about the required number of turns to receive efficiently the programs sent out on the broadcasting wave lengths. This means from 25 to 35 turns on a tube $3\frac{1}{2}$ or 4 in. in diameter. By tapping off every turn between the twenty-fifth and thirty-fifth turns, it is possible to vary the wave length of the circuit to rather close limits. To vary it within the limits of one turn, a Vernier variable condenser can be used either in parallel or in series with the primary coil.

The secondary coil should have about 50 turns and the tickler coil, 70 turns. Where the variometers are used, they should have from 30 to 60 turns on the primary and approximately the same number on the secondary.

"What is the actual value of a potentiometer, and how can it be connected into the circuit?" is a question that has come to me hundreds of times.

When the ordinary type of B battery, tapped in the last few cells, is used, the difference in the voltage can be varied only by $1\frac{1}{2}$ -volt steps. A potentiometer makes a finer adjustment possible. To hook one into a standard circuit, it is necessary to connect the negative of the B battery with the moving member, or slider, and the negative of the storage battery with one end of the potentiometer, while the positive pole is connected with the other end of the resistance element of the potentiometer. The plate voltage can then be varied within small limits by moving the slider of the potentiometer from one end of the resistance element to the other.

"How are Vernier condensers connected into a circuit?" troubles many of my correspondents.

Vernier condensers simplify the critical tuning of the set. Most radio fans have

(Continued on page 124)

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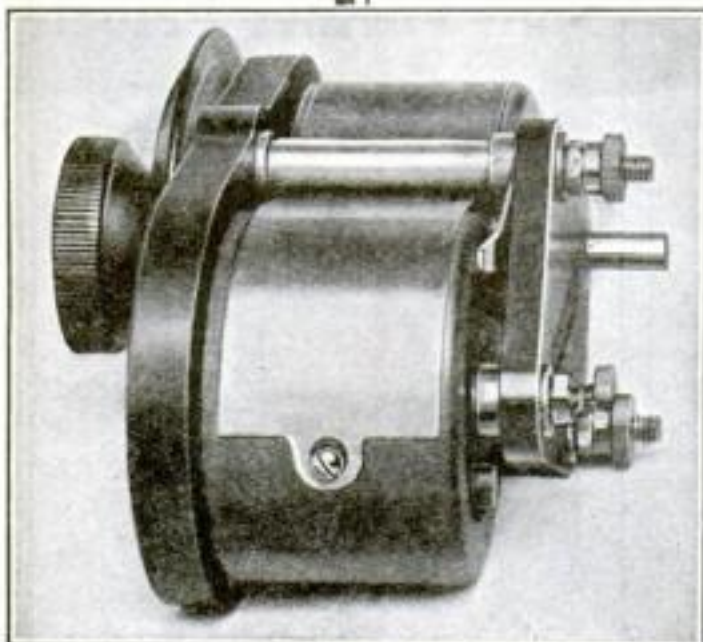
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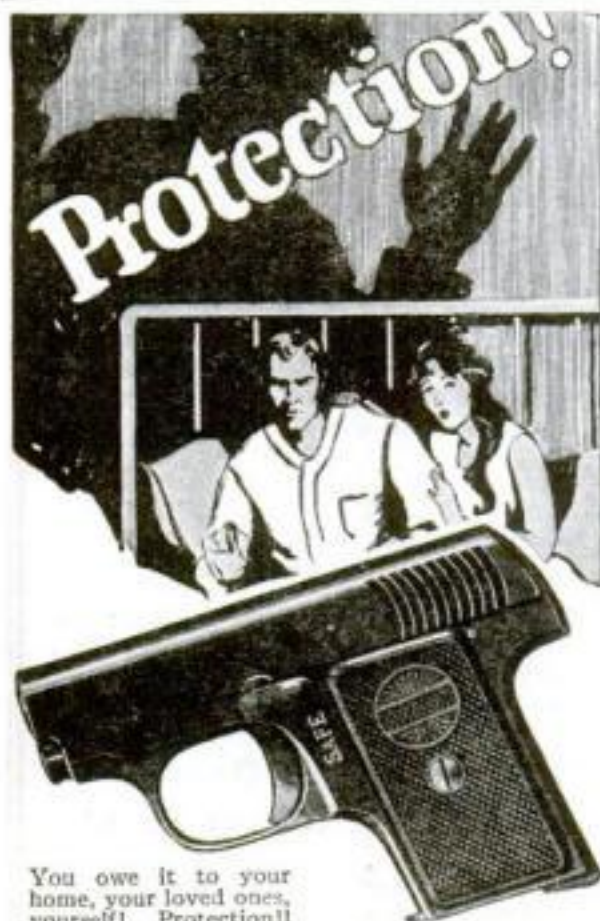
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THE HOME WORKSHOP

Your Radio Questions

(Continued from page 123)

had the experience of bringing in a station without being able to tune it in to best advantage because a very slight adjustment would lose the station. To overcome this difficulty, Vernier condensers should be connected in parallel with condensers already in use.

Typical of questions that come under this division of how to increase the range of radio sets are, "Should the rotary plates be connected with the ground or the aerial side of a circuit?" and "Should the condenser be connected with the ground lead or the aerial lead?"

Wherever possible, the rotary plates should be connected with the grounded part of the circuit. In a secondary circuit, the lead from the secondary coil going to the A battery should be grounded and the rotary condenser plates should be connected with this side of the circuit. The reason for this is that the rotary plates are the ones connected with the shaft of the condensers and a certain capacity effect is introduced between the hand that is grounded and the part of the circuit to which the rotary plates are connected. If the rotary plates are connected with ground, however, this capacity effect will not be present.

This covers pretty fully the main types of questions I receive as to how to increase the range of the set without resorting to the use of radio frequency amplification.

"I am getting pretty good results," say the other great group of my correspondents; "but I'd like to know how I can make the music come in as loud as a phonograph."

In order to get greater volume, it is often necessary to use two stages of amplification for use with a loudspeaker, and if you "want it as loud as a phonograph," it may be necessary to use three stages of audio frequency amplification, as described on page 98.

It is often advisable to use what is termed a "grid biasing" or C battery. This may consist of about five flashlight cells connected in series, or a small 22 1/2-volt B battery may be used. The positive 22 1/2-volt terminal is connected with the negative of the 22 1/2-volt detector or B battery. The F terminals of the transformers, instead of being connected with the A battery filament circuit, are connected with the various taps or binding posts of this new biasing battery. Experimenting with various values of battery voltage will soon show the values that give best results with a given amount of plate voltage.

These, then, are the questions that come most frequently to the desk of a busy radio information editor. What is your trouble, and what question do you most want answered?

Can You Figure Pulley Diameters?

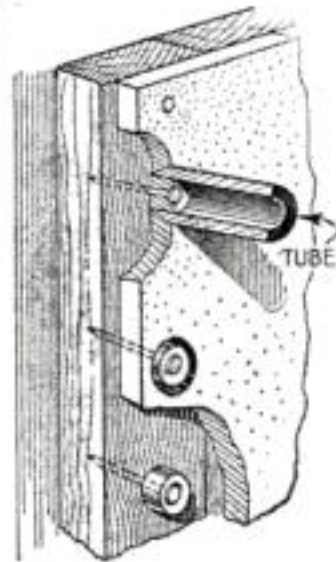
MULTIPLY the number of revolutions of the driven pulley by its diameter and divide the product by the number of revolutions of the driver, in order to find the diameter of the driver. Conversely, to find the diameter of the driven, multiply the number of revolutions of the driver by its diameter and divide the product by revolutions of the driven.

The Shipshape Home

How to Do the Odd Jobs

Removing Wallboard

TO REMOVE wallboard with a clawhammer or a nail puller in such a way that it is not cracked or disfigured is next to impossible. It can be done, however, by cutting out the wallboard around the nails with a steel tube, as shown.



When the wallboard is off, it is a simple matter to pull the nails with hammer pincers or nail puller.

The tube should be slightly larger in diameter than the heads of the nails, and if the cutting end is sharpened, it will go through the board more easily. The holes do not prevent the wallboard being used over again for any

work where the joints are covered by strips.—W. A. SAUL, Cambridge, Mass.

Spring Painting

BY TAKING advantage of your spare time on a few pleasant spring days, you can do much to improve the appearance of your house. Doing your own painting as far as possible saves money and a successful result is certain if the surfaces are properly prepared, a good grade of paint is used, and the paint is brushed vigorously into the pores of the wood and spread in thin, uniform coats. The tendency of amateurs is to put on too heavy coats, which look well temporarily, but are apt not to dry thoroughly and therefore crack and sometimes prevent the surface from being repainted until the old pigment has been burned off.

Scrape off all old, loose paint with a wire brush, putty knife, or scraper. If the surfaces are greasy or very dirty, they should be washed with soap and water. If the wood has not previously been painted, coat with shellac all knots and sappy places.

Prepared paint should be thoroughly mixed by first shaking the unopened can, pouring about two thirds of the thin top liquid into another can, stirring the remaining oil and pigment with a stick until the mass is uniform, and gradually restoring the thinner vehicle until the whole is thoroughly mixed. Then pour the paint from one pail to another a number of times.

The brush should be kept moderately filled with paint and applied to the surface with a horizontal motion. The first coat over previously painted surfaces, especially if hard and non-absorbent, should be reduced somewhat with equal parts of turpentine and raw linseed oil. On new surfaces or old surfaces that are absorbent, raw linseed oil should be added to the first and second coats in quantities sufficient to fill the wood well, and a little turpentine can also be used profitably. Its purpose in the first coat is to insure the paint penetrat-

(Continued on page 126)

Let Me Make A Man of You



Are you dragging yourself from day to day always ailing and complaining—always tired and despondent—suffering from Backache, Indigestion, Constipation, Dyspepsia, Nervousness, Vital Depletion, etc., etc., your Biliousness showing in your face—your lack of energy in your eyes? Have you and your family given up hope that you will ever be a real man again, achieve success and amount to anything in the world? Have you lost ambition and allowed your youthful ideals to slip down into the bog of physical defects and unfitness? Then you are the man I want to help.

Pull Yourself Together

Brace up—you can come back—there is a way out—you can be a real man again. You can regain your vigor and vitality, your health and strength—you can conquer the weaknesses that are undermining your body and brain—you can root out the results of Bad Habits and neglect and fill your life with the success and joy of abundant health.

It is Not Too Late. There is hope for you. It doesn't matter what brought you to your present physical condition—it doesn't matter how many methods you have tried in vain—or how often you have been disappointed. You can be saved from the scrap heap of worn-out humanity and be rebuilt into a red-blooded specimen of vital, magnetic Manhood.

I Can Re-create You

There isn't the least doubt about it. I know that my scientific methods will make you a 100% man. I have helped and am helping thousands of men and women, boys and girls, many of whom had given up all hope of relief. I can do the same for you. I have no pills or powders, dope or drugs to offer you—no foolish fads or fancies—no starvation diets or tedious, expensive routines. My methods are safe, sensible and scientific and are based on the immutable laws of Nature. These are the principles that I applied to my own body and won the World's Award as the Finest Specimen of Physical and Health Attainment. Look at my picture and note the evidences of rugged health, strength, vigor and endurance. You can be as I, if you will, thru the application of the same wonderfully effective principles that made me successful. I want to help you—I can rebuild, rehabilitate and restore you with

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THE HOME WORKSHOP

The Shipshape Home

(Continued from page 125)

ing properly and, in the second, to reduce the gloss.

After the first priming coat is dry, fill all nail holes, cracks, and crevices with pure linseed oil putty.

If paint gets on the window panes, it can be removed either by scraping with a safety razor blade or softening with a paint and varnish remover or hot acid vinegar.

If gloves are not used to protect the hands, coat them with vaseline or with a heavy soap lather well rubbed into the pores and allowed to dry.—F. T. B.

"Nailing" Plaster

To FASTEN in place plaster that has come loose from the laths, I use what I call "screw nails." They are made from large headed roofing nails, as shown. The threadlike groove is cut with a small rattail file, the head of the nail being held with pincers. When the thread has been cut as far as needed, the nail is placed in a vise and the screwdriver slot made with a hacksaw.

Holes are made in the loose plaster with a small bradawl and the nails are rubbed on a cake of old laundry soap and then screwed through the plaster into the laths. The heads, being large and very thin, hold the plaster firmly and yet are invisible when the wall is papered.

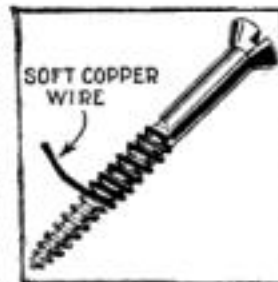
Fifteen years ago I used these nails to fix ceilings that were loose and looked as if they were ready to drop, and they are still in good condition. The plaster itself was good, but the clinchers on the back of the lath had broken off.



I have often seen men try to drive small nails into loose plaster, only to have the springy laths throw the plaster to the floor. Wood screws are no better than nails because they break the plaster and the heads are too small.—JOHN R. DODGE, Normal, Ill.

Making Screws Hold

A SCREW that has been taken out and put in so often that it is loose, can easily be made to hold by winding a length of soft copper wire around the threads, as shown. This has the effect of increasing the diameter of the threaded part and usually will serve the same purpose as plugging the hole or using a larger screw. The "kink" is a particularly useful one in rehanging screen doors and storm doors or dresser mirrors.—A. W. K.



Removing "Bloom"

IF THE piano case develops a surface film known as "bloom," wipe it off with cheesecloth moistened slightly with a few drops of alcohol, and immediately rub gently with a soft, dry cloth. If this treatment is persisted in, the bloom will become less and less troublesome.—F. H.

This One



5J0R-XRZ-ZBEW

THE HOME WORKSHOP

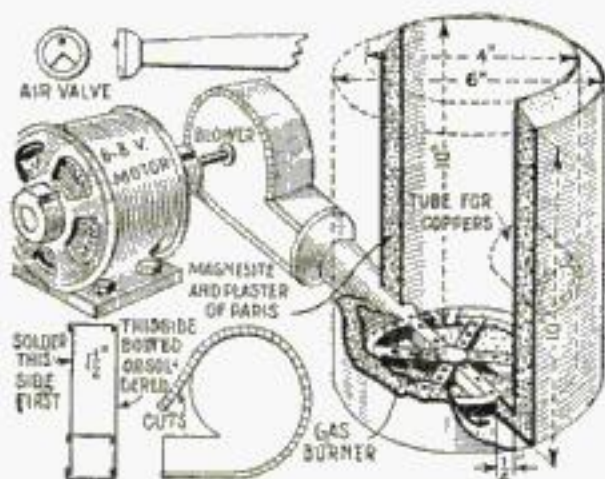
Small Blast Furnace Burns
Coke or Charcoal

FOR those jobs that require more heat than a gasoline blowtorch will furnish, especially if gas is not available for fuel, a small blast furnace for charcoal or coke may be made at little cost, as illustrated. Its use is not restricted to the house, because the blower can be run from an auto storage battery. It will melt 10 lbs. of lead and heat a pair of soldering coppers in 15 minutes, and is therefore a valuable furnace for tanners and plumbers.

The body is a coffee canister and the air inlet is a burner from an ordinary gas stove or gas plate, which may be obtained from a junk dealer. Cut two vertical 2-in. slits in the tin at the bottom about 1½ in. apart and bend out the piece between them.

Fill the bottom 1½ in. deep with a mixture of either 3 parts magnesite and 2 parts plaster of Paris, or 4 parts fire clay and 1 part ordinary clay, with sufficient water to form a thick paste. Put in the gas burner and push it down until it rests level on the bottom. Then bend down the small flap and cut it to fit the pipe.

Obtain another can that will fit in the canister with about 1-in. clearance all



Details of the furnace and blower

around and cut out the bottom in such a way as to leave a ¼-in. rim all around, as shown. Push down this can until it rests on the burner and pour in the slot between the cans a solution of either of the previously mentioned mixtures with a little water added to make it thinner.

If soldering coppers are to be heated, a hole should be made about 5 in. from the bottom and lined with metal tubing to make a neat job.

The construction of the sheet metal blower, which may be permanently connected with the furnace or not, as preferred, is made clear in the blower detail. If the last side to be put in place is to be bolted on, solder the nuts on the inside so that they cannot turn. The fan can be made of sheet metal or obtained from any electric repair shop that handles vacuum cleaners. A small battery rheostat will be found useful in operating the blower.

Brass may be melted in this furnace by starting the fire and putting the crucible right in the coals. Then pack more coal around the sides, cover the furnace with a lid, and start the blast. If soldering coppers are to be heated, start the fire with the blast, shut off the air, and then put in the coppers.

This furnace may be used safely indoors, although it is a wise precaution to put a heavy piece of metal or asbestos under it. —STANLEY TRIER, Whitefish Bay, Wis.



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